How to RFID

With printers from Avery Dennison

Revision history

Revision	Date	Author	Changes
N/A	Before 2007	M. Leiblich	Changes have not been tracked in the past
7	2007-12-19	R. Boettcher	Layout and document structure reworked Section RFID basics removed Section EasyPlug command description limited to commands not already described in the EasyPlug manual (part of the printer documentation)
8	2008-05-30	R. Boettcher	· Section 3.1.2.1: Power level data updated (EU and US module data included) · Section 3.3.2.2: AWID Module identification clarified · Section 3.3.2.1: AWID Firmware compatibility list updated (EU Module => 4.10B) · Section: 4.1.1: HF Technology EAS bit added · Section 5.3.5.3: #RFC command description for modifying the EAS bit added · Section 6.2.7: Sample job for EPC/EAN128 4x6” shipping label added · Section 6.3 added an example for modifying the EAS bit of HF tags
9	2008-06-26	R. Boettcher	Various changes indicating differences between standard printer firmware with RFID features and semi custom RFID firmware · New section 1 Summary of supported RFID features · New section 2.4.8 Processing failures (errors) – Bad tag signaling · Section 2.2: size limit of 224 bits user memory for NXP chip based tags removed · Section 3.3.2.1: size limit of 224 bits user memory for NXP chip based tags removed · Section 3.1.2.1 Power level: power level tables and diagrams for AWID EU and US RFID reader modules updated · Section 3.1.3 Parameters for error handling: description for parameter “Try times” added · New section 3.1.5 Recommendations for web / material handling · New section 5.1.3 Operation / EasyPlug command matrix · Section 5: description of #SI command updated · Section 5: description of #RFL command added · Section 6: sample for usage of access password (EPC Gen 2 tags) updated
10	2008-08-21	R. Boettcher	Adaptation of examples witch use PadLeft or PadRight functions to the syntax documented in the EasyPlug manual and implemented in firmware versions >= x.33 (first standard release with RFID). The syntax was changed compared with previous semi custom releases! Affected examples: · Section 6.2.3: Write / Read / Print EPC with consecutive numbering · Section 6.2.6: Writing a SSCC-96 to tag · Section 6.2.7: EPC/EAN128 shipping label (SSCC + SSCC-96) + automatic transfer from Barcode SSCC (NVE) to EPC using a scanner
11	2008-09-01	R. Boettcher	· Section 1.2: Correction of Korea Frequency Range · Section 2.3: table Table 2 – Available RFID kits updated, added 64-08 UHF kits, HF kits for DPM/ALX removed

Revision	Date	Author	Changes
12	2008-09-22	R. Boettcher	· Section 3.3.2.1: List of approved AWID Firmware versions updated · Section 1.1: added “PEM” in the list of RFID enabled systems · Section 2.3: added part numbers for PEM / HF RFID kits · Section 2.4.4 “Using pre qualified supplies”: added a reference to the “RFID Label Design & Printer Setup Guide” and the RFID inlay qualification process · Section 4.2 "Inlay qualification” added Updated features list for printer firmware version Vx.34 · Several sections: added transponder fields “AFI” and “DSFID” in field descriptions; feature lists and command descriptions · Section 5.3.4.1: description of #SRF command; optional use of the size parameter for reading the TID, MEMBANK field · Section 2.4.6: description of the new write based hotspot-/profile test of firmware version >= X.34
13	2009-08-31	R. Boettcher	· Finalization of changes introduced in revision 12 (no significant changes of content)

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1 Summary of supported RFID features

1.1 RFID enabled systems (machines)

System	UHF Technology Region	HF Technology
AP 5.4	supported EU / US / Korea	not supported
64-04 / 64-05 / 64-06	supported EU / US / Korea	supported
ALX 924 / ALX 926	supported EU / US / Korea	not supported
PEM	not supported	supported

For details please see section 2.2 and 2.3.

Limitations

– 64-0x printers: the combination of dispenser option and RFID option is not supported.

1.2 UHF Technology

Feature / Classification	Supported standards / variants / options	Notes
Regions / Frequencies	EU: 869.525 MHz US: 902-928 MHz (Frequency hopping) Korea: 910-914 MHz (Frequency hopping)	For each region a specific RFID reader module is required.
UHF protocols / standards	EPC Class 1 Gen 2 ISO / IEC 18000-6C	protocols supported only by semi custom releases of printer firmware: · EPC Class 1 (“Alien” protocol) · EPC C0 / C0+ (“Matrix” protocol) · EPC V1.19 Rev 2 · Impinj Zuma · ISO 18000-6B (U-Code, HSL)
Addressable tag data tag fields	EPC Class 1 Gen 2 tags: · EPC (64 / 96 Bit, up to 240 bit) · User memory (up to 512-Bit) · TID · Access password · Kill password · AFI	Please note the limitations for specific fields

Feature / Classification	Supported standards / variants / options	Notes
Operations	General · optional 2 pass verification of written data Data field specific · EPC: R / W / L / U · User memory: R / W / L / U · TID: R · Access password: W / L / U · Kill password: W / L / U · AFI field (*1): R / W	R = read content of data field W= write / change content of data field L = lock (write protect) data field (requires a non-zero access password) U = unlock (remove write protection) *1): printer firmware >= Vx.34
Tag data encoding standards	All EPC global defined tag data standard encodings are supported.	It's preferred to generate the encoded data in the host system in hex ascii encoding. If this is not possible the printer can do various data transformations on bit- and byte level to build EPC conform data structures from basic identifiers itself. Direct transformations of EPC global defined URI encodings are not supported.
Special features	· Chip protection feature (64-0x + ALX only) · Bad tag signal: in case of tag processing errors a "bad tag signal" (BTS) is sent to the AI-board.	The bad tag signal (BTS) signal can control a bad tag removal unit (for example the bad tag separator).

If not noticed otherwise all features are supported by the AP 5.4, the 64-0x printers and the ALX print and apply system.

Limitations

AP 5.4 with cutter

– Inlay placement must be close to the inlay depending optimum position.
This is due to the limited back feeding capabilities in general (ribbon wrinkling!) and exceptionally for use of the add-on cutter (possible loss of contact between material and feeding mechanism) and the need for additional material movement to reach the RFID operating/coupling position.
– Minimum length of label >= 50 mm
This is due to the requirement to have the inlay in the optimum position and the position of the RFID antenna inside the printer.

See section 2.5 for details.

AP 5.4 dispenser

– Inlay placement must be close to the inlay depending optimum position.
This is due to the limited back feeding capabilities (ribbon wrinkling!) and the need for additional material movement to reach the RFID operating/coupling position.

1.3 HF Technology

Feature / Classification	Supported standards / variants / options	Notes
Regions / Frequencies	global: 13.56 MHz	
HF protocols / standards	· ISO 15963 · ISO 18000-3-Mode 1	
Supported transponders (tags / chips)	· Infineon my-d · NXP I-Code 1 · NXP I-Code SLI · NXP I-Code EPC · NXP I-Code UID · TI Tag-it HF ISO	
Addressable tag data tag fields	· User data (block data) · UID · AFI (*1) · DSFID (*1) · EAS-Bit	
Operations	Data field specific · User data (block data): R / W · AFI: W · DSFID: W (*1) · EAS-Bit: W / L (*1)	R = read content of data field W= write / change content of data field L = lock (write protect) data field U = unlock (remove write protection)
Tag data encoding standards	n/a	
Special features	· Chip protection feature (64-0x + ALX only)	

*1): printer firmware >= Vx.34

2 RFID in a printer

2.1 Introduction

A RFID capable printer from Avery Dennison can be viewed as a normal label printer extended by RFID specific parts (an RFID reader and an antenna). These parts are available as RFID-Kit for AVERY printer (compare table 1).

In addition to that you need smart labels. Smart labels are labels that are combined with an RFID tag. On the one hand these labels can be used as normal labels to print human readable information on it and on the other hand as RFID tags to read/write data in their memory.

2.2 Supported Technologies

Currently supported tags operate at either 13.56 MHz (HF) or 915/869 MHz (UHF). The following is a steady growing list of supported tag types from different vendors.

Manufacturer	Tag type Name	ID	Memory	Blocksize in byte	Nr of blocks (user data)	Standard
HF Technology						
NXP (Philips)	I•CODE 1 (A)	2	512 bit	4	16 (11)[1]	proprietary
	I•CODE SLI (A)	3	1024 bit	4	32 (28) [2]	ISO 15693
	I•CODE EPC (B)	7	96 bit EPC / no UID	1	17	proprietary
	I•CODE UID (B)	8	192 bit / with UID	1	24 (12)	proprietary
Texas Instruments	~~Tag-it HF~~	~~*~~	~~256 bit~~	~~4~~	~~8~~	~~proprietary~~
	Tag-it HF ISO (A)	4	2048 bit	4	66 (64)[3]	ISO 15693
Infineon	My-d (A)	1	10240 bit	10 (8)[4]	128 (125)[5]	ISO 15693
	My-d V2 (A)	1	10240 bit	4	256 (250)	ISO 15693
UHF Technology						
Matrics (1)	EPC class 0	5	64 / 96 bit EPC	na	na	proprietary
Alien (1)	EPC class 1	6	64 / 96 bit EPC	na	na	proprietary
NXP (Phillips) (1)	U•CODE EPC 1.19	10	64/96 bit EPC + 256 bit user data	1	32	proprietary
	U•CODE HSL	11	2048 bit	4	64	proprietary
Impinj (1)	Zuma / EPC class 0+	12	64/96 bit EPC + up to 64 bit user data	2	depending on EPC size	proprietary
Various	**EPC class 1 Gen2**	**15**	64..240 bit EPC (+ available user data)	2	0 / 14 / 32[6]	EPC class 1 Gen2

Table 1 – Supported transponder types

Key: ~~Text~~ not longer supported
(option) (A) or (B) = different module options, one per module supported
(1) only supported by semi custom firmware (not standard firmware version X.33 and later)

2.3 Hardware prerequisites

For the different RFID technologies, printers and printer generations there are RFID upgrade options available. See the following list of part numbers.

Application	Country	Description	Variant	Part number
HF	WW (13.56 MHz)	Option for 64-04		X1237
		Option for 64-05		X1232
		Option for 64-06		X1238
UHF	EU (869.525 MHz)	Option for 64-04/05		X1443
		Option for 64-06		X1444
		Option for AP 5.4		X1445
		Option for ALX/DPM 4/5"	LH/RH	X1446
		Option for ALX/DPM 6"	LH/RH	X1447
	US (915 MHz)	Option for 64-04/05		X1448
		Option for 64-06		X1449
		Option for AP 5.4		X1450
		Option for ALX/DPM 4/5"	LH/RH	X1451

[1] 5 blocks are reserved internally. They are hidden from the user. There is an effective block range from 0 up to 10.

[2] 4 blocks are reserved internally. They are hidden from the user. There is an effective block range from 0 up to 27.

[3] There is an effective block range from 0 up to 63.

[4] There are 2 extra bytes for each block reserved for administration purposes. From an user point of view there are 8 bytes per block.

[5] The first three blocks are reserved for internal purposes - for example ISO unique identification number (UID). These blocks are NOT hidden from the user. These blocks cannot be written, but can be read. There is an effective block range from 0 up to 127. Block 0 contains UID.

[6] NXP / Philips chips only

Application	Country	Description	Variant	Part number
		Option for ALX/DPM 6"	LH/RH	X1452
	Korea (910~914MHz)	Option for 64-04/05		X1675
		Option for 64-06		X1676
		Option for AP 5.4		X1677
		Option for ALX/DPM 4/5"	LH/RH	X1678
		Option for ALX/DPM 6"	LH/RH	X1679
64 bit series “High Performance” – RoHS compliant – Generation 3				
HF	WW (13.56 MHz)	Option for 64-04/05 HP		X1701
		Option for 64-06 HP		X1702
		Option for PEM 4/5”	LH/RH	X1716
		Option for PEM 6”	LF/RH	X1717
UHF	EU (869.525 MHz)	Option for 64-04/05 HP		X1687
		Option for 64-06 HP		X1688
		Option for 64-08 HP		X1787
		Option for ALX/DPM 4/5" HP	LH/RH	X1689
		Option for ALX/DPM 6" HP	LH/RH	X1690
	US (915 MHz)	Option for 64-04/05 HP		X1691
		Option for 64-06 HP		X1692
		Option for 64-08 HP		X1788
		Option for ALX/DPM 4/5" HP	LH/RH	X1693
		Option for ALX/DPM 6" HP	LH/RH	X1694
	Korea (910~914MHz)	Option for 64-04/05 HP		X1695
		Option for 64-06 HP		X1696
		Option for 64-08 HP		X1789
		Option for ALX/DPM 4/5" HP	LH/RH	X1697
		Option for ALX/DPM 6" HP	LH/RH	X1698

Table 2 – Available RFID kits

2.4 Processing of RFID tags in the printer

2.4.1 General

RFID operations are seamlessly integrated in the printing process of an AVERY printer. AVERY printers are printing labels by means of EasyPlug commands. EasyPlug is a command oriented language for printer control. There are some command extensions and several new commands to EasyPlug that handle RFID specific operations. For the correct use of these commands it is necessary to understand process of printing first.

The basic RFID operations are READ data from tag and WRITE data to the tag. There is one more operation called SELECT that is important for RFID communication. Because there can be more than one tag in the range of a reader each tag has to be distinguished from another. This can be done by asking tags for their identification number and select one tag because of this number. Once a tag is selected you can operate on a tag with READ/WRITE operations. (The selection is an integrated part of each READ/WRITE operation, so there is no special command the user needs to issue for this).

2.4.2 Mechanical specifications / restrictions

Definitions:

– Mechanical distances –
PH-CT: distance from print head (dot-line) to knife (cutting position)
PH-TB: distance from print head (dot-line) to tear bar (tear off edge)
PH-CA: distance from print head (dot-line) to center of printers RFID antenna
PH-DE: distance from print head (dot-line) to dispensing edge

– Mechanical restrictions –
MBF: maximum back-feed distance (without losing “grip” or ribbon wrinkling)

– Label/Inlay specific / depending distances –
LA: inlay / label specific distance from top of label to leading edge of inlay antenna
ILG: label specific inter label gap (distance between two subsequent inlays)
OPA: RFID operating point measured from leading edge of antenna of inlay
OPL: RFID operating point measured from leading edge of label (=> antenna offset)

Figure 1 shows a label web in the paper path of the printer with symbolic dimensions.

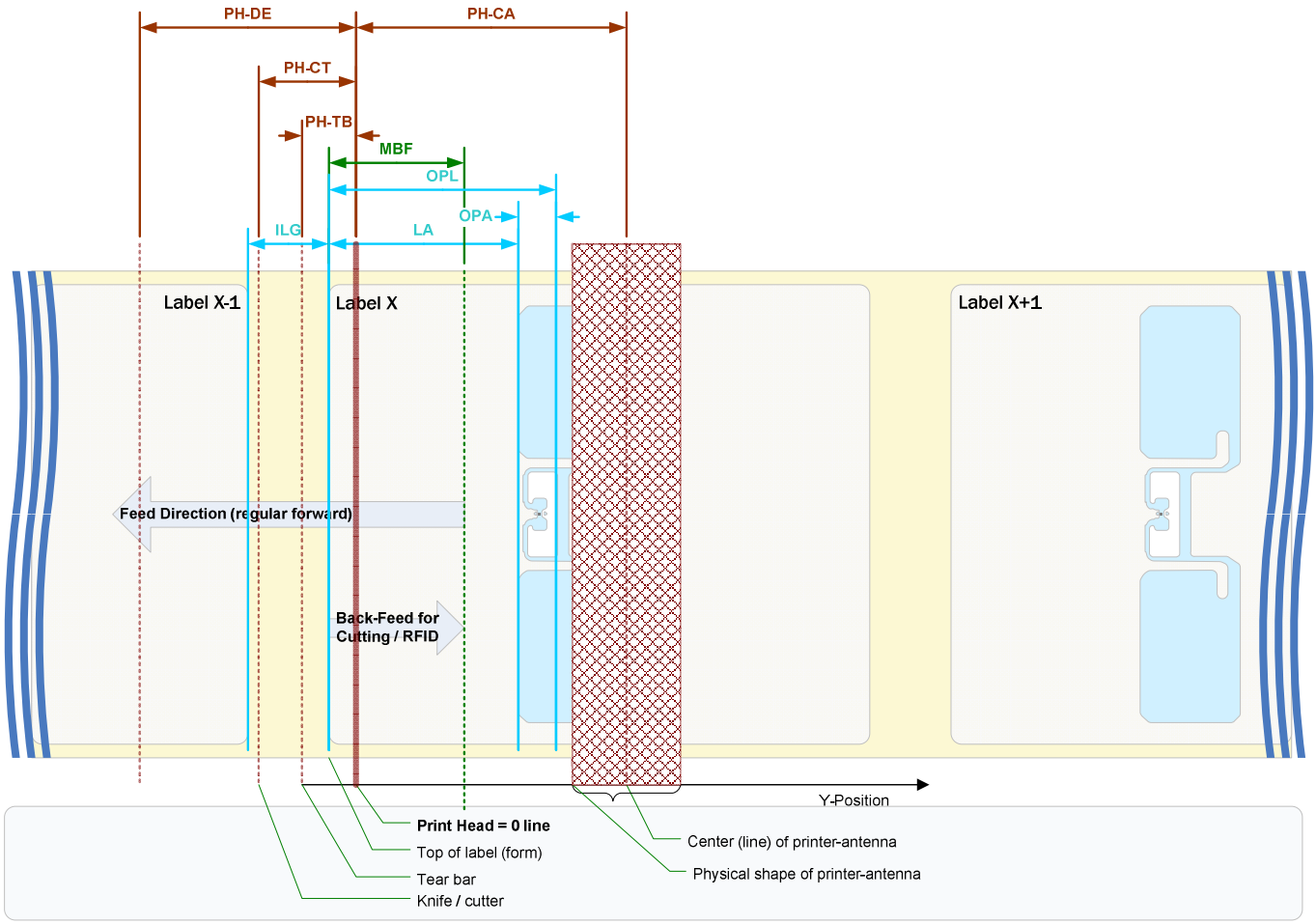


Figure 1: mechanical dimensions of the paper path (and label)

Printer	PH-CT [mm]	PH-TB [mm]	PH-CA [mm]	PH-DE [mm]	MBF [mm]
64-0X	17.13	10.50	62.00		48.50
AP 5.4	17.00	10.00	46.50		16
ALX 92x / DPM	n/a	n/a	50.00	24.20 (short dispensing edge) 39.80 (long dispensing edge)	ca. 100

Table 3 –Paper path dimensions of printer relevant for RFID

2.4.3 Inlay position / Tag antenna coupling

Smart labels with RFID functionality are treated by the printer in a **two phase process**. At first RFID functionality is executed and afterwards the regular print processing is made. To communicate with an RFID transponder it has to be in the range (RF field) of the built in reader antenna and it must be the only tag in range. For this purpose the Easy Plug command #IM has been extended with a parameter called **RFID antenna offset**. It defines the distance between label start and optimal coupling point position. In other words, it determines how much the label needs to be back feed to bring the transponder in the right position near the printer's antenna.

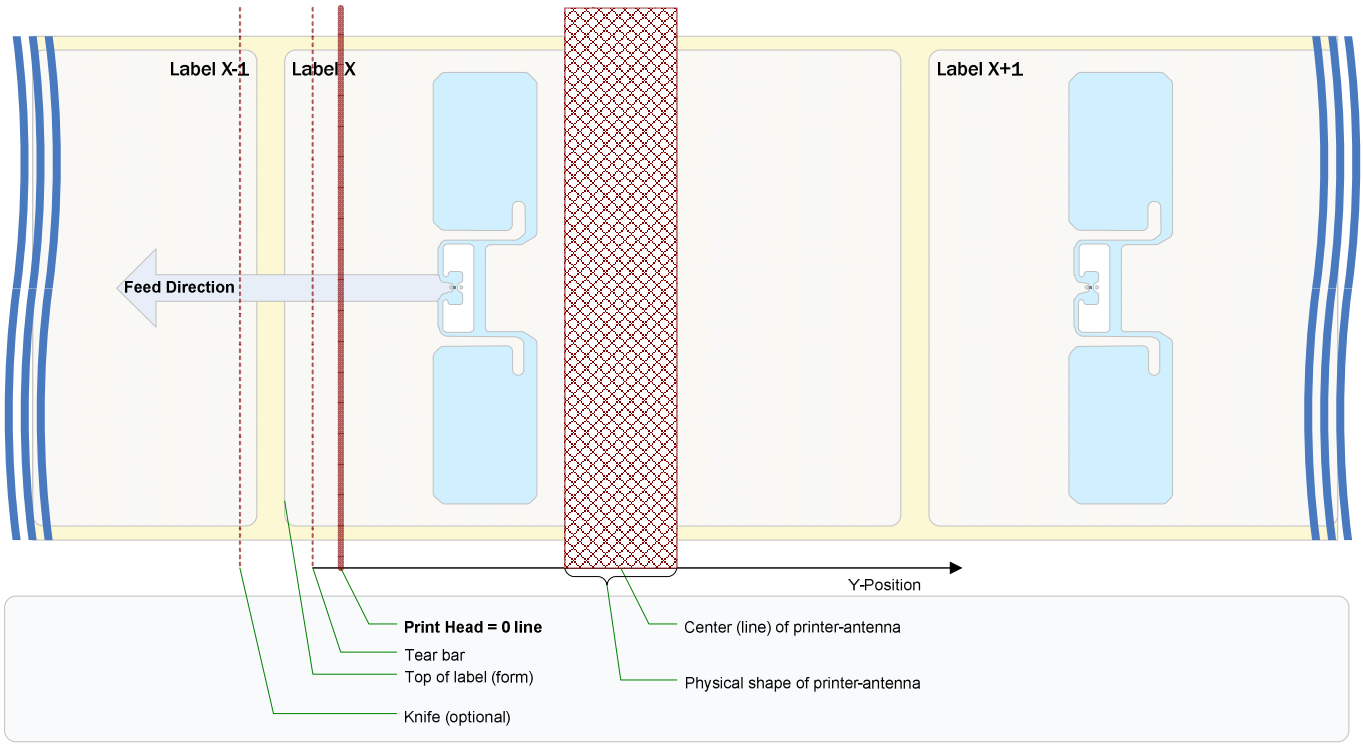


Figure 2: positioning at label start

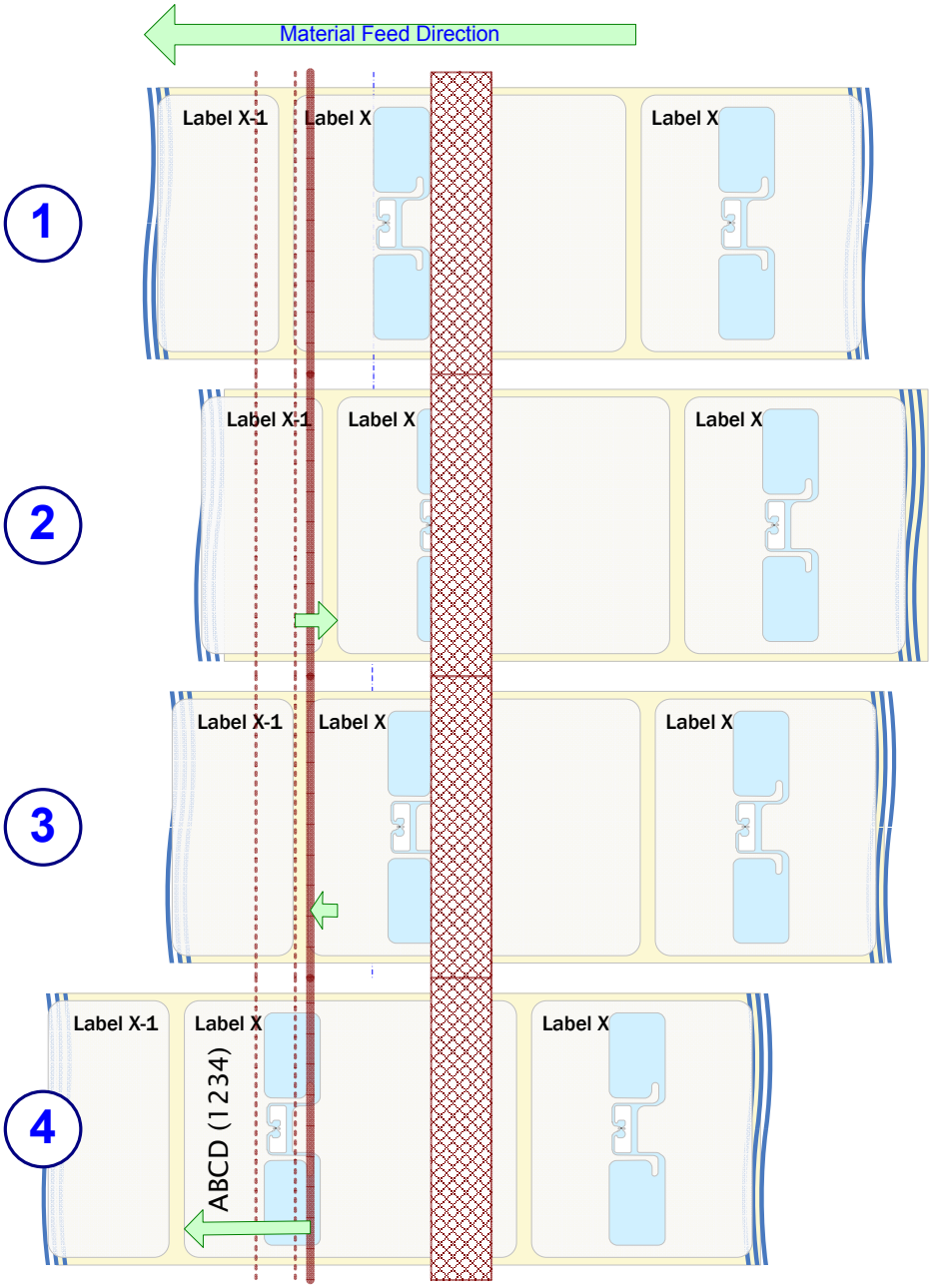


Figure 3: processing steps of RFID encoding and label printing:

(1) resting position before start of RFID processing / printing
(2) back-feeding of label to the RFID encoding position (move inlay antenna to best-match position with printer antenna)
(3) forward-feeding to bring start of label to dot line again (after RFID encoding)
(4) label printing in progress

Label positioning is the first action that takes place when processing a RFID label. Afterwards all RFID commands are executed. When this is finished the label is repositioned to the beginning and all other printing actions are executed.

2.4.4 Using pre qualified supplies

RFID starter kits

Avery Dennison offers RFID starter kits for the RFID printers. The starter kit contains also RFID supplies (labels). For those supplies a pre qualification was made and the parameters for adjusting the printer to this supply are available on the supply data sheet. The supply is referenced by an Avery article number. If there is no data sheet included in the supply package, please ask your reseller or the technical support team for the supply data sheets.

Application requires the use of another inlay?

Avery Dennison publishes a document called “RFID Label Design & Printer Setup Guide”. The content of this document is the essential extract of an intensive inlay qualification process. Goal of that process is, to find the optimum label design parameters and printer setup parameters for an “optimized” label.

It’s highly recommended to use the parameters determined in the RFID inlay qualification process for the processing of inlays in the printer.

For further details see section 4.2…

2.4.5 Finding and defining the optimum coupling position (the “Hotspot”)

If the position of the hotspot measured from the beginning of the label is close to the relative position of the antenna, little or no material movement between RFID processing and printing is necessary. This leads to an optimal performance (throughput).

But, due to shielding / coverage reasons this may be not the best position for coupling!

UHF Technology

Printer	Position of the center-line of the UHF antenna relative to print head (dot-line)	Inlay placement window (+/- offset from ideal position)
64-0X	62.0 mm	+/- 48 mm
AP 5.4	46.5 mm	+/- 16 mm
ALX 92x / DPM	50.0 mm	*TBD (depending on dispensing mode, rewinder etc.)*
PEM	n/a	n/a

Table 4 – Antenna position relative to print head

HF Technology

Printer	Position of the center-line of the HF antenna relative to print head (dot-line)
64-0X	62 mm
AP 5.4	n/a
ALX 92x / DPM	80 mm
PEM	n/a

Table 5 – Antenna position relative to print head

2.4.6 Hotspot-/Profile test

How to execute the hotspot-/profile test

To find an optimized antenna position, execute a “Hotspot test”. To execute a hotspot test use the menu item “RFID Parameters / Hotspot test”.

Repeat the Hotspot test with different power level settings to find a combination of power level and antenna offset which makes sure only the inlay in direct contact (located nearby) the antenna is processed and no adjacent read or writes occur.

With attenuation power control (firmware version <= X.33):

Start with minimum power (high value, for example 245) and increase the power (decrease the power level value) in steps of 5 or 10. Starting with low power identifies the most sensitive position.

With dBm power control (firmware version >= X.34):

Start with minimum power (low value, for example 5) and increase the power (increase the power level value) in steps of 5. Starting with low power identifies the most sensitive position.

How to hotspot-/profile test works

At the beginning the printer positions the start of label (top of label) to the center of the printer’s antenna. During the test the label gets feed stepwise by 2.0 mm until the end of the label reaches the position of the printers antenna. The length of the label is determined by the current material length setting.

At each position the printer tries to write an EPC code to the tag with different power levels. The range of the power level to be tested is determined by the current power level and ranges from current value -5 dBm ... current value + 5 dBm. At each test point (position / power level) a single write attempt is made and the result (success or failure) gets recorded into the printer’s memory.

After the complete label has been processed, a test result graph is generated and printed to the same or a following label. For short labels the printout can be printed to a following label due to slight slippage during feeding and gap detection. If it’s required to print exactly to the same label, decreasing the material length by 1..3 mm may help, especially if material length was adjusted with the auto-calibrate feature.

Hot to read the result printout

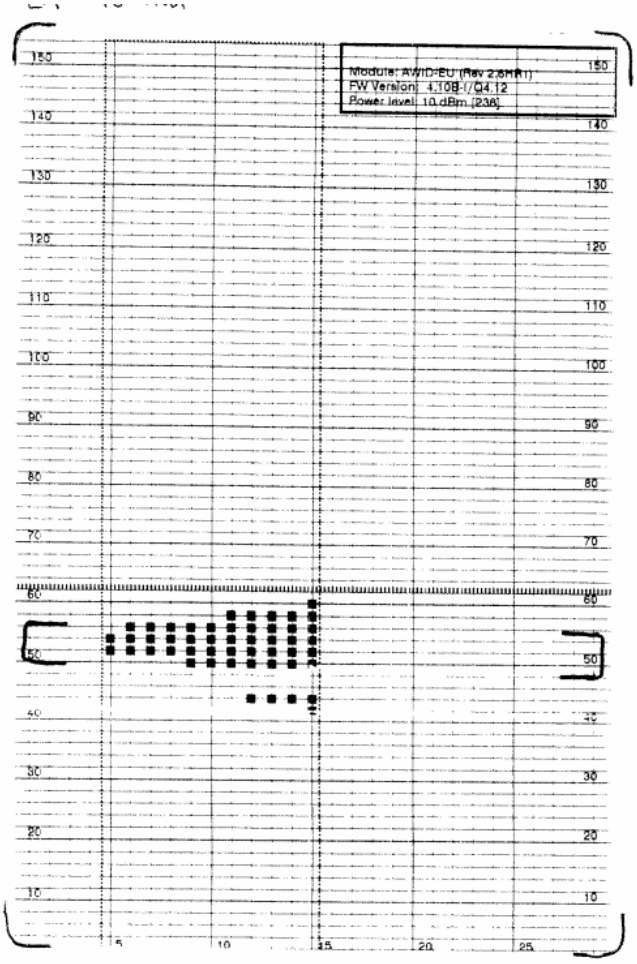
The Y-axis (feeding direction) direction shows the position (unit mm) of the “hotspot” relative to top of label (begin of label = 0 mm). The position determined during analysis of the printout can be transferred 1:1 to the antenna-offset parameter of the EasyPlug #IM command.

The X-axis (across the label) shows the power level (unit dBm). Power level increases from left to right side (0 dBm at the left side ca. 30 dBm on the right side). Possible range depends from the capabilities of the RFID reader module.

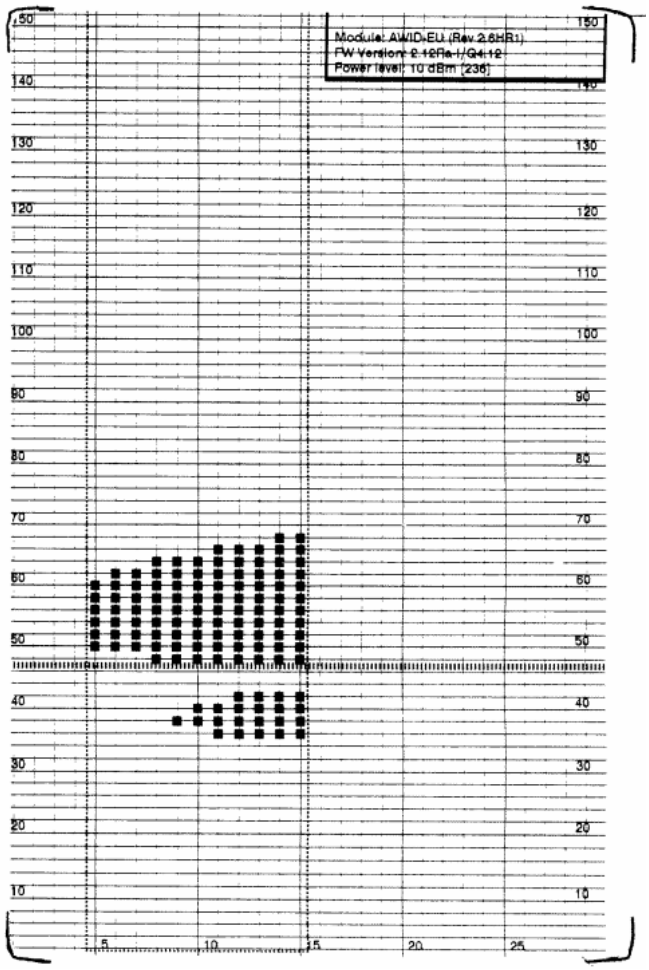
A black dot (filled square) shows a successful encoding for the related position and power level. The complete tested range (position and power level) is indicated by the dotted line rectangle.

Current settings of the RFID components (RFID reader module, firmware version, current power level) are shown in the top right corner.

The thick dotted line across the label shows the position of the printer’s antenna (if TOL is at the print-head).



AD 222 in 64-05 with AWID-EU reader module

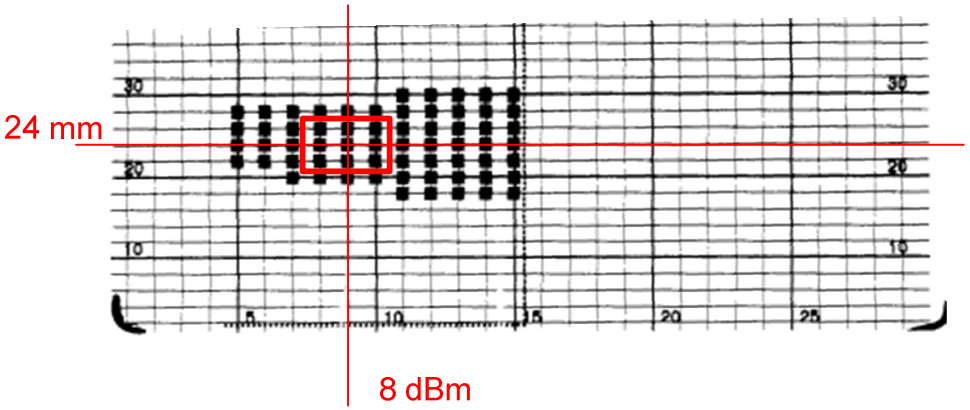


AD-222 in AP 5.4 AWID-EU reader module

How to select the antenna offset

Choose a region where at least 3 x 3 adjacent “dots” of the matrix show a successful writing. If there is more then one region like this, choose one which is located near the center-line of the antenna in the printer (see 2.4.4). The goal is to avoid unnecessary web movement to reach optimum throughput and to avoid problems from “loosing” the material if a cutter or tearbar is used.

A note regarding the power level: please keep in mind “less is better”! Only use a high power level if there is no large enough area in a low power level region for safe and reliable operation.



Limitations of this test

The built-in hotspot-/profile test was designed to be a customer self-care instrument. It can not completely replace the advanced and more detailed tests made during the inlay qualification process done by Avery Dennison. If published printer settings are available for a specific inlay, it's highly recommend to use that settings before making several trials with self determined settings. During the inlay qualification process a lot more inlays are tested to intercept possible performance decreases from placement and sensitivity tolerances. A test with a single RFID label can never provide that level of reliability…

The following limitations apply:

1) The test can not determine write zones (sensitive zones) located before or after the label itself. For very short labels where the inlay is located near top of label and / or near the end of the label (for example pure paper faced inlays), the sensitive zones might be located in before or after the inlay.
2) The test can not determine whether crosstalk effects have an influence. Crosstalk effects: while trying to write to the inlay nearest the printer's antenna, the radio energy is reflected or otherwise forwarded to the adjacent inlays (on the web) and those inlays respond to the write attempt to. For details about cross talk/adjacency problems see section 4.2.
3) The material length must be adjusted to meet the real material length (+/-10%), otherwise the printout fails. If the inlay is located near TOL in a (very) long label, it's required to run the test for the whole label even if it's expectable to have a large "dead" zone at the end.

2.4.7 Processing failures (errors) – Invalidating labels

For HF technology the RFID command execution starts with selecting the tag under the antenna. When tag selection fails, it is retried like every RFID command that can fail. After a defined number of retries (compare RFID parameter „Number of CMD retries") it is concluded that there is no transponder under the antenna or the transponder is defective. This is documented by **invalidating the label** with printing a characteristic pattern (diagonal bars) on the label.

Afterwards no more printing is done for this label and the next label is tried. This is repeated until a valid transponder is found or a defined limit of invalid transponder in sequence is reached (defined in parameter „Max tags to stop").

When this maximum number of invalid labels in sequence is detected, job processing is stopped. It is assumed that a certain number of invalid transponder is an indicator for a severe problem that has to be solved first. Afterwards job processing can be continued.

For UHF technology the step “selecting the tag” is skipped (not necessary). The RFID processing starts immediately with the requested write or read operations. If one of the operations fails (is not successful) the label gets invalidated in the same way is described for HF technology.

2.4.8 Processing failures (errors) – Bad tag signaling

As mentioned before if the RFID processing fails the label is invalidate. For automated processes this is not sufficient because it must be made sure in not-encoded label is not released (forwarded) into a further process. As a prerequisite for this requirement a print and apply system must signal RFID processing errors via a control interface.

A mechanical unit for removal of invalid labels (also called bad tags) can be triggered by that signal and remove the invalid label from the processing line.

BTS on the Applicator Interface

For the print and apply system ALX 924 / ALX 926 the bad tag signal is available on the applicator interface as output signal “BTS”. For details see [AI-Manual].

An optional Bad Tag Separator can be attached to the ALX to remove the invalid labels by sticking them on a waste roll.

Alternative solutions

Please note: the BTS is not available on the USI.

2.4.9 Statistics

There is information about RFID operations in a printable status. It tells you for example how many operations of each type have been processed and how many of them have failed (compare).

RFID Status	
System version	V5.33 Aug 01 2008
Printer type	Avery 64-05
Nr. Cmd retries	3
Nr invalid tags	3
Statistics	
Nr of tags	707
Nr invalid tags	72
Scrap rate	10.2 %
Total Nr SELECT	755
Invalid SELECT	17 %
Total Nr Read	730
Invalid Read	730
Total Nr WRITES	507
Invalid WRITE	29 %
…	

Figure 4: example of printable RFID information

2.5 Using a cutter

There is a limitation by moving not more than 48 mm backwards for 64-0x and 17 mm for AP 5.4. For relevant antenna positions in different machine/printer types see 2.4.4

This limitation must be considered if labels with a non-optimal inlay placement shall become processed. The inlay must be placed behind the optimal position (away from top of label) to prevent additional back feeding for reaching the RFID operation position. The optimal inlay position depends from the printer type and the inlay itself. Optimal placement data for most common inlays is available on request.

Printer type	**Distance dotline / cutter**
AP 5.4	17.00 mm
64 series	17.15 mm

Table 6 – Distances between dot line of print-head and cutter (cut line)

3 Prepare the printer

3.1 Configuration

3.1.1 Activating the RFID-option

The very first thing to do for using RFID in an AVERY printer is to **activate** the **RFID** option. To activate RFID set parameter „Interface Parameter / OPTIONS / RFID Option“ to the value of appropriate COM interface (internal serial RS232 interface). After confirming the entry the printer reboots itself with appropriate settings for internal use of COM.

Printer type	RFID option (internal connection)
AP 5.4 (Marlin CPU board)	Serial Com3
AP 5.4 (Redfin CPU board / Marlin MLK)	Serial Com4
64 series / DPM / ALX 92x (Gen 2 CPU board)	Serial Com2
64 series “High Performance” / DPM / ALX 92x (Gen 3 / Dolphin CPU board)	Serial Com4

Table 7 – Serial port for RFID option

3.1.2 Material depending RFID parameters

3.1.2.1 Power level

The Power level setting is a very critical part of the whole setup of an RFID printer. The Power level setting controls the output power of the radio module of the RFID reader. The output power must be adjusted an a way that the inlay to be processed (in direct coupling with the antenna) gets enough “radio” energy to be able to respond to the request from the RFID reader – but on the other side to avoid the activation of adjacent tags (resulting in unwanted reads or writes from multiple transponders).

To find the right setting can be a tricky and time consuming process. It depends mainly from the dimensions of the material especially the pitch between inlays and the type of inlay used.

To ease this process Avery Dennison has introduced a RFID inlay qualification process, were popular transponders / inlays get tested in the lab. See section 4.2 for details.

There is a simple rule of thumb: adjust to the *lowest* power level which gives constant success. Applying to much power leads to problems caused by reflections and adjacent reads/writes.

Please note: the RF transmit power depends from the built-in RFID reader module, which is a different one for the different regulatory regions (EU/ETSI, US/FCC, Korea).

Power control changing an “attenuation” value

Up to and including printer firmware versions Vx.33, the power level is adjusted by a numerical value which controls the attenuation of the transmitted radio signal. Resultant in reverse logic: high numerical value => low power, low numerical value => high power. The output power doesn’t follow a linear curve, especially in the range of 255 – 200. Therefore changes in small steps may result in very large differences in read / write success.

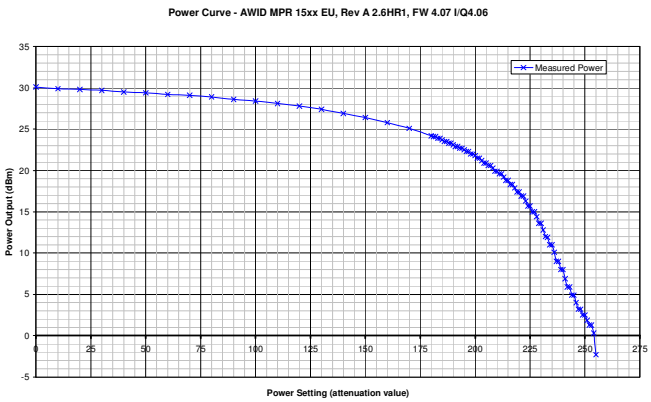
In most technical documents radio output power is measured in the unit of the physical power level mili watts (mW) and is presented as logarithmic scaled value in dBm.

The following table provides the correlation between the numerical setting and the physical value for the EU module (C1616, hardware Rev A 2.6HR1) and the US module (C1184, hardware Rev E).

C1616 – EU Module (Rev A 2.6HR1)

Please note: range 0..30 dBm

Power dBm	Attenuation Value
0	255
1	253
2	251
3	248
4	246
5	245
6	243
7	241
8	240
9	238
10	236
11	234
12	232
13	231
14	230
15	227
16	223
17	221
18	218
19	213
20	208
21	204
22	199
23	190
24	182
25	170
26	160
27	140
28	110
29	70



C1183 – US Module (Rev E)

Please note: range 18..30 dBm

Power dBm	Attenuation Value
18	255
19	230
20	200
21	160
22	140
23	110
24	90
25	70
26	55
27	40
28	25
29	10
30	0

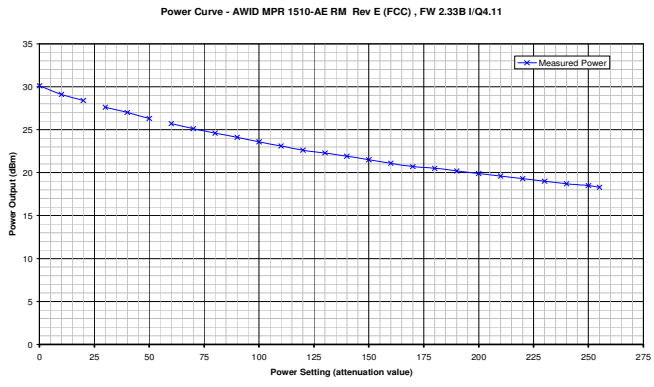


Table 8 – Power level to attenuation mapping tables

As visible from the table and charts above there are big differences in the range of adjustable power for the EU/ETSI and US/FCC modules. So a power level setting (attenuation value) for the EU module can not be simply transferred to the US module.

Power control by "dBm" scaled values

Starting with printer firmware version Vx.34 the direct control of the "attenuation" parameter was removed and a new parameter "Power level in dBm" was introduced. The printer detects the built-in RFID reader module type + hardware revision and uses an internal mapping table from the value in dBm to the attenuation value to be send to the RFID reader module. To make it comparable with previously used settings the menu entry for power level adjustment shows the resulting attenuation value from the selected dBm value.

The dBm value uses regular logic (low value = low power) and is in depended from the built-in module.

Please note: For applications using the EasyPlug #PC command for adjusting the power level as part of the printer job an adaptation is needed. The parameter ID for the power level has changed and values need to be converted to dBm. It's not anymore possible to directly change the attenuation value.

Power control via EasyPlug

The RFID power level is adjustable via the EasyPlug #PC command. Changing the value shows immediate effect. (Also during still running jobs, so be careful if working with different supplies.)

Parameter ID

- printer firmware version <= x.33: 5202 -> attenuation value
- printer firmware version >= x.34: 5208 -> dBm value

3.1.2.2 Antenna offset

The antenna offset is defined inside an EasyPlug job using the #IM command. Section 2.4 describes why you need to set the offset and how to find the hotspot.

If you are using a label based on a qualified inlay, the value for the hotspot is mostly identical to the physical antenna position in the printer (when label producer follows recommended inlay placement position). See section 4.2 for how to calculate the antenna offset for a deviating inlay placement.

3.1.3 Parameters for error handling

They can be found in the „RFID Parameter" menu. Their meaning is

Parameter	Effects
Max tags to stop	Number of transponders (tags) that have to be invalid in sequence before a printing job is stopped. This parameter exists because of the assumption that a certain number of invalid transponders in sequence indicate a severe problem. After solving this problem the job can be continued.
Nr of CMD retries	Number of internal RFID command retries (sending a command to the RFID reader module once again of negative status is reported by the RFID reader module) before a fail is reported. For HF technology especially SELECT retries are important when printer is used in noisy environments.
Try Times	UHF technology / AWID RFID reader module only: This value controls how often the RFID reader module itself tries to perform a requested RFID operation (read / write) until an error is reported. Setting a high value will result in lower throughput in the case of bad tags or general non-matching RFID processing parameters (power level, antenna offset). The default value is set to 10 to get best throughput. Increase this value if you have a poor yield rate resulting from a noisy environment.

3.1.4 Chip protection

Another useful feature that can be activated on demand is “Chip protection”. Chips are part of the RFID inlay inside a smart label. Most often they are much thicker than label material. Printing means putting pressure and heat to foil and label. This might damage the chip. To prevent damage to the area where the chip resides, the print head can be lifted in this area. Any printed output within the protected area is prevented.

Different implementations of chip protection

In printers without the capability for lifting the print head the chip protection features defines an unprintable area. Any output in the chip protection area is suppressed so it stays blank. If you don’t use the chip protection keep in mind that printing at the edges and on the inlay itself results in lower print quality due to the changes of thickness of material.

Printer	Effects
AP 5.4	Chip protection area is defined as unprintable area. The head can’t be lifted. The chip protection feature can be used to avoid printing inside the area of the inlay which may result in lower printing quality because of the alternating thickness.
64-0x	Chip protection area is defined as unprintable area. Additionally the head will be lifted before the start of the chip protection area to ensure the path is open when the chip passes the print line. The area is enlarged by the way the head physically needs to lift completely and go back down. The enlargement depends from the print speed (higher speed – higher enlargement)
DPM / ALX	Same as 64-0x
PEM	n/a

How to control the chip protection feature

EasyPlug: the #IM command gives full control over the chip protection feature. A value of 0 for the chip position/offset disables the chip protection feature, a value greater than zero activates the chip protection feature. Providing no value is identical to providing zero (which disables the feature).

Using the menu:

Parameter	Effects
Chip protection	Enable this parameter if you would like to activate chip protection. (See note below)
Chip size	Visible if and only if parameter “Chip protection” is enabled. Defines size of area in regard to printing direction that is excluded from printing. For calculation of the protected area the chip size is centered around the the chip position (so the size counts one times only) + a print speed depending offset for head up and down movement.
Chip offset	Visible if and only if parameter “Chip protection” is enabled. The offset defines the beginning of the chip protection area.

Note: The setting from the #IM command has highest priority. It activates (> 0) or deactivates (=0) the chip protection feature depending from its value. After the #IM command was used in a job the menu reflects the last setting from #IM command. De facto the menu setting “chip protection” can be seen as an informative / read only parameter.

3.1.5 Recommendations for web / material handling

Adjusting the material pressure rollers

Please take care the pressure rollers don’t run over the RFID chip. Doing so will destroy the RFID inlays.

Adjusting the punch level

The punch detection for RFID labels can be a little bit tricky due to the different “darkness” of the different zones of in RFID label: liner only, liner + paper, liner + paper + RFID inlay plastics, liner + paper + RFID inlay antenna.

If it is not possible with the automatic punch detection mode to get reliable punch detection, the manual punch detection might help.

Set the parameter “Punch mode” to “manual” and adjust the parameter “Punch level” to a value which is around 15 units higher then the measurement value when liner + paper (without inlay) is visible for the punch sensor.

For details about that please see the printer manual.

3.2 Additional support functions

3.2.1 Functions for testing purpose

Menu item	Function
Tag type (*1)	Choose tag type that is assumed as base for “Read EPC” / “Write EPC”
Read EPC	Function to read and display EPC from smart label near printer antenna. Only smart labels with chosen tag type are considered. The function stays in an endless loop until the user cancels with the “ESC” key. In each loop a read attempt is made and if a tag could be read the EPC is displayed otherwise in line of “---“ chars.
Write EPC	Function to write EPC to smart label near printer antenna. Only smart labels with chosen tag type are considered. The EPC that is written is created by printer firmware. The function stays in an endless loop until the user cancels with the “ESC” key. In each loop a write attempt is made and if the EPC could be written to an tag “OK” is displayed otherwise “fail”. Each loop is signaled by a moving star in the progress bar. The EPC which becomes written is fixed, but in every loop the first 16 bits are chosen randomly.
Hotspot tests	Performs a test to find the sensitive write zones of the inlay (label). See 2.4.5 for details.

(*1) supported only in semi custom printer firmware. Standard printer firmware only supports EPC Gen2 protocol (tag type) for UHF technology.

3.2.2 For information

Menu item	Function
Module	Designator to identify RFID reader module that is mounted inside the printer. Printer firmware version <= Vx.33: This information is quasi static – it depends from the detected reader, but is not queried in a direct way from the reader module. Unfortunately it doesn’t reflect the hardware revision which is an in important for firmware updates. Printer firmware version >= Vx.34: During boot time the printer identifiers the built-in RFID reader module. For the AWID reader (UHF technology) module The value shows the module type (“AWID”), the regulatory region identifier (“EU”, “US”) and the hardware revision level (“Rev 2.6HR1”, “Rev E”). For the HF technology it shows only the module type (“FEIG”).
FW Version	Version number to identify firmware that is used by internal RFID reader module.

Both values are also accessible via remote parameter query mechanisms and in the “setup” file.

3.3 AWID RFID module firmware update

3.3.1 Update procedure

Note: firmware update for RFID reader module is handled like normal printer firmware update (compare printer service manual), especially “*.ihb” files are treated like “*.s3b” files

4) Update printer firmware to appropriate version named in column “printer firmware”.
5) Update main reader firmware to version in same row (e.g. 4.10B for EU region and Gen2) - printer resets after finishing update
6) Update I chip firmware to version in same row (e.g. 4.06) - printer resets after finishing update
7) Switch off/on printer
8) Update Q chip firmware to version in same row (e.g. 4.06) - printer resets after finishing update
9) Switch off/on printer
10) Check for function by activating “Read EPC” and “Write EPC” in menu RFID parameter

Caution

- Check hardware compatibility list (Never upgrade a module with FW 2.xxy to 4.xxy)
- Take care, do not switch off printer while updating
- main download takes about 15 minutes (on AP5.4)
- I/Q chip download takes about 5 minutes each (on AP5.4)

3.3.2 Dependencies

3.3.2.1 Printer firmware / Reader module firmware

Applicable for UHF printer only (with RFID module from AWID). Bold highlighted versions are the most current approved and recommended versions.

Version Main	Version I/Q	Purpose	Printer firmware	
			640x / ALX 92X / DPM	**AP5.4**
2.05M	??	original version	< V3.40	none
		C1183 – US Versions (Rev E)		
2.17M	2.10	split version US 915 MHz	>= V3.40	>= V2.50
2.24M	4.03	adds EPC class 1 Gen2 US	>= V4.00X1	>= V3.00X1
2.28M	4.03	Gen2 US with R/W user data	>= V4.22X01 (Gen2) >= V5.02X01 (Gen3)	>= V3.22X01
2.33M	**4.11**	Gen2 US **(recommend version for US)**	Semi custom firmware >= V4.22X01 (Gen2) >= V5.02X01 (Gen3) Standard firmware >= V4.33 (Gen3) >= V5.33 (Gen3)	Semi custom firmware >= V3.22X01 Standard firmware >= V3.33 (Gen3)
		C1616 – EU Versions (Rev 2.6HR1)		
2.02Rd	4.06	Do not use – upgrade to 4.10B	Not compatible	Not compatible
2.05B	2.10	split version EU 869 MHz	>= V3.40	>= V2.50
2.11B	4.03	adds EPC class 1 Gen2 EU	>= V4.00X1	>= V3.00X1
4.07B	4.06	Gen2 EU with R/W user data	>= V4.22X01 (Gen2) >= V5.02X01 (Gen3)	>= V3.22X01
4.10B	4.06	Data integrity issue for EPC Gen2 Monza 2 chips corrected	Semi custom firmware >= V4.22X01 (Gen2) >= V5.02X01 (Gen3) Standard firmware >= V4.33 (Gen3) >= V5.33 (Gen3)	Semi custom firmware >= V3.22X01 Standard firmware >= V3.33 (Gen3)
2.12Ra	**4.12**	Supports 240-bit EPC Data integrity issue for NXP U-Code G2XL / G2XM chips corrected **(recommend version for EU)**	Standard firmware >= V4.33 (Gen3) >= V5.33 (Gen3)	Standard firmware >= V3.33 (Gen3)
		C1674 – Korea Versions (Rev 2.6H2)		
4.45Me	4.11	full support of 512 bit user memory of NXP U-Code G2XM chips	Semi custom firmware >= V4.22X01 (Gen2) >= V5.02X01 (Gen3) Standard firmware >= V4.33 (Gen3) >= V5.33 (Gen3)	Semi custom firmware >= V3.22X01 Standard firmware >= V3.33 (Gen3)
4.85Me	**4.12**	Supports 240-bit EPCs Data integrity issue for NXP U-Code G2XL / G2XM chips corrected **(recommend version for EU)**	Standard firmware >= V4.33 (Gen3) >= V5.33 (Gen3)	Standard firmware >= V3.33 (Gen3)

Table 9 – AWID firmware versions

3.3.2.2 Hardware compatibility list (AWID reader modules only)

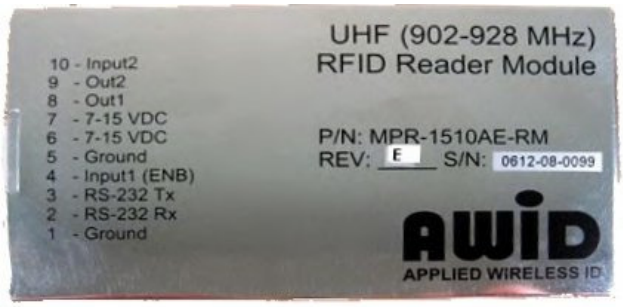
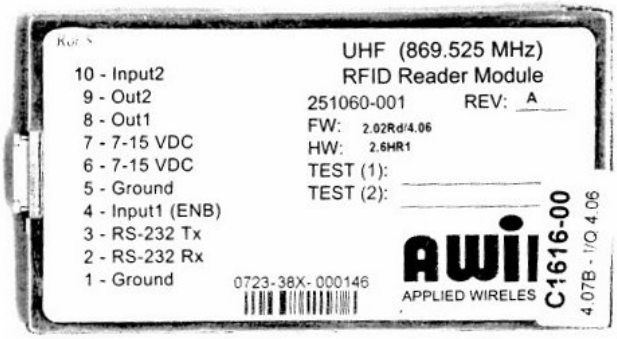
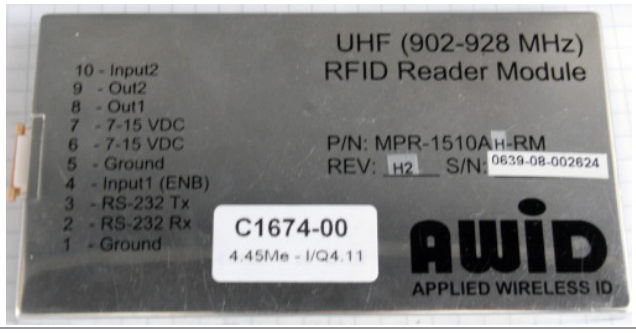
Region Frequency **Article number**	**Identifier on module**	**Approved Firmware**
US 902-928MHz **C1183**	UHF (902-928 MHz) MPR **1510AE**-RM **REV: E** and/or P/N: **MPR1510AE-RM** 	**2.33M + I/Q 4.11**
EU 869.525MHz **C1616**	UHF (869.525 MHz) a) REV:H and/or P/N: MPR1580AH-RM b) MPR1580A-RM REV: A and HW: 2.6HR1 c) **251060-001, Rev: A and HW 2.6HR1** 	**2.12Ra + I/Q 4.12** 4.10B + I/Q 4.06 4.07B + I/Q 4.06
Korea 910-914 MHz **C1674**	UHF (902-928 MHz) MPR-1510AH. RM Rev H2 	**4.85Me + I/Q 4.12**

Table 10 – AWID hardware compatibility list

4 RFID Transponder / tags / inlays

4.1 Memory layout (data fields) of RFID Tags

4.1.1 HF Technology

HF Technology is based on a flat memory model without separation into specialized memory areas. All data is organized as blocks of memory with equal size.

Note: a block of memory can only be written as a whole. Write operations where the length of data provided is not a multiple of the size of a block are padded with 00 bytes.

The data type ID is used in commands for reading or writing data to select the field of tag where the operation should work with.

Field [data type id]	Contents / function	Size in Bits (Bytes)	Read / Write access
Block data (User data) [0]	– is organized in blocks of 4 bytes (depending from chip type) – size varies (depending from chip type) – blocks can by access only as a whole	See Table 1 – Supported transponder types	Read / Write
UID [1]	– called Unique Identifier – is a tag identifier (contains a chip manufacturer ID, a chip type ID and a serial number) – is defined in [ISO15693]	64 (8)	Read only
EAS Bit	– used in electronic article surveillance (EAS) applications – it a single bit which can be set or cleared (not set) – can be locked permanently which blocks any future modification attempt	1	Write / Lock
AFI [6]	– AFI = Application Family Identifier – can be used to filter out non application specific tags in inventory operations – is defined in [ISO15693]	8 (1)	Write
DSFID [8]	– DSFID = Data Storage Format Identifier – is defined in [ISO15693]	HF: 8 (1)	Read / Write

Table 11 – Data fields of HF tags

4.1.2 UHF Technology (EPC tags)

The data type id is used in commands for reading or writing data to select the field of tag where the operation should work with.

Field [data type ID]	Contents / function	Size in Bits (Bytes)	Read / Write access
EPC [2]	– called Electronic Product Code – is a product identifier – is defined in [EPC1]	96 (12) 64 (8) up to 240 (30)	Read / Write
TID [1]	– called Tag Identifier – is a tag identifier (contains a chip manufacturer ID, a chip type ID and optional a serial number) – is defined in [ISO15693] + [EPC1]	32 (4) 64 (8) depending from manufacturer	Read only

Field [data type ID]	Contents / function	Size in Bits (Bytes)	Read / Write access
User data [0]	– also called user memory – is organized in blocks of 2 bytes – size varies (depending from chip type) from 0 to X	0 224 (28): NXP G2 512 (64): NXP G2XM	Read / Write
Kill password [3]	– this password must be referenced when using “Kill tag” command – must be 4 bytes – is defined in [EPC3]	32 (4)	Write only
Access password [4]	– this password must be used to authorize certain access to tag memory e.g. locking and unlocking memory – must be 4 bytes – is defined in [EPC3]	32 (4)	Write only
Memory bank(s) [5]	– a memory bank presents the physical memory area of a tag – banks are defined as follows: – 0: Access + Kill password – 1: EPC – 2: TID – 3: User data *Direct access to a memory bank is depreciated since behavior is undefined (behavior depends from size of memory bank areas of different tags and additionally depends from RFID reader firmware module.* *A direct read or write access to a memory bank should only be considered if there is no direct way to access a specific information* *Note: some memory banks may be unreadable due to security restrictions*	Vary in size	Read only
AFI [6]	– AFI = Application Family Identifier – is a part of PC (Protocol Control) bits in the EPC memory bank (but not part of the EPC itself) – possible range for values: 0..511 (0x00 … 0x1FF) where the MSB is used as identifier for a not EPC global defined identifier, and bits to lower 8 bits are named “NSI” (Numbering System Identifier) – is defined in [EPC3] for UHF technology –	9 (2)	Read / Write
Memory Block [7]	– There is no field “memory block” in EPC Gen 2 transponders! – This field-identifier is only a helper to allow EasyPlug commands the addressing of any memory area inside the transponders memory without being limited to the predefined field identifiers. – see EasyPlug command description for details	varying	Read / (Write)

Table 12 – Data fields of UHF / EPC Gen 2 tags

4.2 Inlay qualification

4.2.1 The inlay qualification process

Using only the built-in functionality of the RFID enabled printer it's more or less difficult to find out the best settings for the RFID parameters to process a given RFID label in a safe manner.

Furthermore some of the very important parameters are already fixed (unchangeable) if a converted RFID label is used. That's mainly the placement of the inlay inside the label:

a) distance from top of label in feed direction,

b) placement from the left edge of the label,

c) the orientation of the inlay (typical forms: chip first or chip trailing), and

d) the distance (pitch) between two subsequent inlays (in subsequent labels).

All of those parameters have significant influence on the performance and throughput of the encoding (and printing) process in the printer.

To get optimum performance and throughput it's necessary to have the inlay placed in a printer- and inlay specific optimum position in the label. This assures well coupling between the printers antenna and the (and only that) inlay "near" the printers antenna.

On the other side it's important to have the right minimum pitch (distance) between to subsequent inlays to avoid the unwanted writing (and reading) to more than one inlay at once. These unwanted side-effects are also called "crosstalk" or "adjacency" effects.

Please note: due to the EPC being "the" unique identifier of a EPC Gen 2 transponder, it's not detectable whether only one or multiple transponders have been "hit" by a write operation during the encoding. This would first be possible after a unique EPC was written to each transponder – and what a bad luck – mostly the first and only operation to be done is to write a unique EPC into the transponder.

So the only way to ensure individual programming of the transponders with a unique EPC is, to make sure it's only one transponder in coupling with the printer's antenna. This can be attained by

a) using an antenna in the printer with a small "beam width" (restricted by physical limits),

b) using as less RF transmit (output) power as possible (but still enough to turn the transponder on),

c) use metal parts inside the printers paper path as shielding,

d) use a distance (pitch) between two inlays which avoids having two inlays at the same time in the RF field of the printers antenna, and which additionally avoids energy transmission between subsequent inlays.

Another parameter having influence on the performance of an inlay is the RF regulatory region where the printer shall operate. This is due to

a) varying sensitivity of the inlay itself for the different frequencies used,

b) different RFID reader modules used in the printer for the different regulatory regions (EU/ETSI, US/FCC, Korea) => different RF output/transmit power and receive sensitivity

c) frequency depending RF field characteristics of the printers antenna

Because there are so many system- and transponder (inlay) specific parameters, it's necessary to test a selected transponder (inlay) in the target printer before designing and producing a label for a specific application.

To avoid this high burden for system setup, Avery Dennison makes the test of several well known transponders (inlays) in advance. The results of the tests – the recommended parameters for each transponder and printer – are published in several ways. This all together is called the "inlay qualification process".

4.2.2 RFID Label Design & Printer Setup Guide + RFID Suppy Specifications

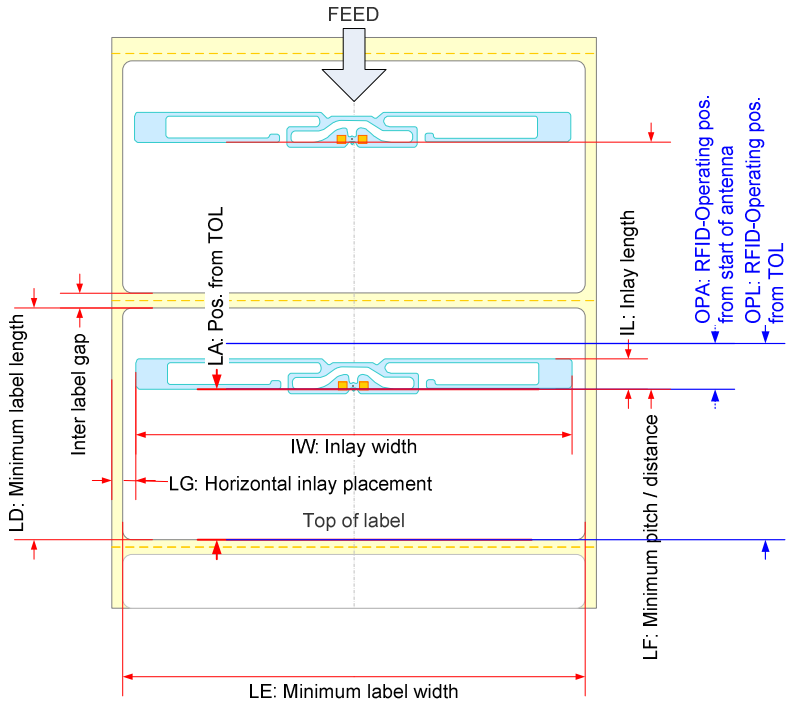
Avery Dennison publishes documents called “RFID Label Design & Printer Setup Guide”. The content of this document is the essential extract of the inlay qualification process required for system setup.

There are several “RFID Label Design & Printer Setup Guides”, one for each RFID enabled printer and RF regulatory region. So care must be taken to use the right document as reference.

Having a specific requirement in an RFID application to use transponder (inlay) A from manufacturer B, it’s often a question to find out what RFID enabled printer is the best to meet given requirements for label design.

In this case it’s a good idea to have a look inside another type of document. Additionally there is one document called “RFID Supply Specification” for each transponder (inlay). This document contains some more details about the transponder / inlay and the parameters for usage in the Avery Dennison printers. The parameters for all printers are contained in the specification for that inlay and can be easily compared. Additionally the document contains manufacturer’s part numbers, inlay dimensions, chip data etc.

4.2.3 Terms used in the inlay specifications and related documents



Transponder / inlay placement dimensions

Dim.	Definition	Explanation
LA	Inlay position from top of label *“offset”*	This dimension is selected to ensure best operating throughput in the printer by having the inlay at the right position for encoding, when the top of the label is at the dot line of the print head. This dimension is printer model specific Please note: the distance is always to the antenna leading edge, not the chip or transponder carrier (inlay base material). This distance is generally given with a +/- 1.5 mm tolerance (otherwise see notes). If required, a deviating inlay position is possible, but requires adaptation of the OPL dimension and leads to decreased throughput. For the system specific placement window see Table 13 below.

Dim.	Definition	Explanation
LG	Horizontal inlay placement *"x-pos"*	Horizontal placement of inlay relative to the left edge of the liner – physically to the inside side of the paper path in the printer. Dimension is given with a +/- 5mm tolerance. Coupling with the transponder changes across the width of the printer paper path. An adjustment for optimal coupling is possible by sliding the antenna of the printer. See Table 13 for the system specific limits). But, if inlay width (distance across the web) is much smaller than the width of the printer's antenna (100 mm), a pre-adjustment through proper placement of the inlay inside the label is required. Please note: especially for the design of narrow size tags (e.g. hang tags) this can become a challenge.
LF	Minimum inlay pitch / distance *"pitch"*	This distance ensures coupling with the transponder in the current label only. Please note that the distance is always to the antenna leading edge, not the chip or transponder carrier (inlay base material). Distance is generally given with a +/-- 1.5 mm tolerance (otherwise see notes).
LD	Minimum label length	Minimum length of the label resulting from dimension LA (inlay placement relative to top of label) and the length of the inlay carrier (base material). Additional backup might be required to ensure a valid label construction (depending from label converting technology).
OPL	RFID operation position relative to top of label	This distance identifies the "sensitive" area of the transponder which must be located in line with the center of printer's antenna for optimum coupling. Distance is given relative to top of label, as printer requires it in that way. If a deviating LA dimension is selected the corrected value for dimension OPL can be calculated by OPL = LA + OPA.
OPA	RFID operation position relative to start of inlay antenna	Similar to distance OPL, but given relative to the leading edge of the transponder's antenna. This value is required to recalculate OPL if a deviating placement position of the inlay from top of label (LA value) is used.

Printer settings

Dim.	Definition	Explanation
OPL	RFID operation position relative to top of label	OPL dimension = parameter "Antenna-Offset" of the EasyPlug #IM command
n/a	Power level	Power Level setting: up to firmware versions x.33 the printer's power level was adjusted by an attenuation value which results in reverse logic (high value = low power, low value = high power) Starting with firmware versions x.34 the printer's power level is adjusted in dBm (a physical unit for the power of RF fields) See section 3.1.2.1

4.2.4 Printer specific dimensions and restrictions

Printer	Position of the center-line of the UHF antenna relative to print head (dot-line)	Inlay placement window (+/- offset from ideal position)	horizontal movement restriction of the antenna (across the web)
64-04/05	62 mm	+/- 48 mm	+ 25 mm
64-06	62 mm	+/- 48 mm	+ 50 mm
AP 5.4	46.5 mm	+/- 16 mm	+ 15 mm
ALX 924 / DPM	50 mm	*depending on dispensing mode, rewinder etc.*	+ 25 mm
ALX 926 / DPM	50 mm	*depending on dispensing mode, rewinder etc.*	+ 50 mm
PEM	n/a	n/a	n/a

Table 13 – Antenna position relative to print head

5 Reading and writing RFID data using EasyPlug

5.1 Design an EASYPLUG job

5.1.1 The Basics

There are several specialized RFID commands and some extended commands. Some of these commands are mandatory and some are optional depending on your application. (For example: the #IM command is extended with antenna offset. This is mandatory information, because a non-zero offset indicates a RFID job.)

Like every EasyPlug job a RFID jobs needs at least a

1) #IM command: defining material parameters and RFID processing parameters (chip type, antenna offset, optional chip protection)
2) #ER / #Q sequence with contains the layout data and the RFID operations (and optional definitions of variables for data handling)

Set the RFID parameters in #IM command based on settings you identified in a material setup phase.

Note: the power level setting can't be controlled using the #IM command. It's accessible only via the printer menu. If there is a need to bind the power level setting directly into an EasyPlug job this can be done using the change system parameter command #PC (#PC5202/<Power level setting>).

5.1.2 Concepts of data handling

Resulting from the continuous enhancement of RFID functionality and improvement of RFID integration with regular printing functionality there are two different approaches to perform RFID read and write operations have been created.

1) the legacy EasyPlug commands
2) the RFID parts of the mechanism for variable data handling

Note: Using approach 2) based on the variable data handling is the preferred (because more flexible and powerful) way to design RFID jobs.

5.1.3 Operation / EasyPlug command matrix

The following matrix shows which EasyPlug commands may be used for specific operations to be performed. Commands which must be used in sequence are listed with a plus sign (+), alternative commands are separated by lines.

Please note: the commands are not listed with complete syntax – only most important RFID specific parameters are shown.

Technology / Tag type	UHF Technology	EPC Class 1 Gen 2					HF echno-logy	Various		
Data field	EPC Code	TID	User memory	Access password	Kill password	AFI field	User memory	UID	EAS-Bit	AFI / DSFID field
Read data field	#RT//2 #SRF2 + #VR/T	#RT//1 #SRF1 + #VR/T	#RT//0 #SRF0 + #VR/T	---	---	#RT//6 #SRF6+ #VR/T	#RT//0 #SRF0 + #VR/T	#RT//1 #SRF1 + #VR/T	---	---
Write data field	#RFW2 #SRF2 + #VW/T	#RFW1 #SRF1 + #VW/T	#RFW0 #SRF0 + #VW/T	#RFW4 #SRF4 + #VW/T	#RFW3 #SRF3 + #VW/T	#RFW6 #SRF6+ #VW/T	#RFW0 #SRF0 + #VW/T	#RFW1 #SRF1 + #VW/T	#RFC	#RFW6 #RFW8
Protect (Lock) data field	(*1) #RFL1/2	N/A	(*1) #RFL1/0	(*1) #RFL1/4	(*1) #RFL1/3	---	---	N/A	#RFC	----
Read data field and send data to host	#RFR/2 + #RFH #SRF2 + #VR/T + #SI8 + #VW/I	#RFR/1 + #RFH #SRF1 + #VR/T + #SI8 + #VW/I	#RFR/0 + #RFH #SRF0 + #VR/T + #SI8 + #VW/I	---	---	#RFR/6+ #RFH #SRF6+ #VR/T + #SI8 + #VW/I	#RFR/0 + #RFH #SRF0 + #VR/T + #SI8 + #VW/I	#RFR/1 + #RFH #SRF1 + #VR/T + #SI8 + #VW/I	---	---
Write data field and send data to host	#SRF2 + #VW/T + #SI8 + #VW/I	#SRF1 + #VW/T + #SI8 + #VW/I	#SRF0 + #VW/T + #SI8 + #VW/I	#SRF4 + #VW/T + #SI8 + #VW/I	#SRF4 + #VW/T + #SI8 + #VW/I	#SRF6+ #VW/T + #SI8 + #VW/I	#SRF0 + #VW/T + #SI8 + #VW/I	#SRF1 + #VW/T + #SI8 + #VW/I	---	---

Table 14 – EasyPlug commands / RFID operations matrix

--- : function / feature not supported

(*1) before the command for activation of write protection the access password must have been written to the tag

5.2 Legacy EasyPlug commands

In a RFID job you can write data to and read data from a tag. Use command RFW to write data to tags, und use either command RT to read data from tag and print it on the label or the combination of command RFR and RFH to get data via the defined communication interface.

These commands can be used all together mixed in one job. Data can be read in the same job when it is written to the tag. Take care that the command that writes data must be placed before (lower line number) a read command when this data should be read in the same job.

For the complete description of the RFID related EasyPlug commands #IM, #ER, #RT, #RFW, #RFR, #RFL, #RFH, #RFC, #RM see “The EasyPlug manual” [A0164].

Note: Using the legacy commands is not the preferred way to read from and write data to a tag. The concept of variable data handling gives much more flexibility for processing data before writing to the tag.

5.2.1 Read and Write operations

Operation	Command(s)	Notes
Read data from tag and print data to label	#RT	
Write data to tag	#RFW	Auto increment of numeric values isn’t implemented => use variable data handling approach instead
Special commands for proprietary tag features	#RFC	allows control the EAS bit of HF tags

5.2.2 Other RFID operations

Operation	Command(s)	Notes
Read data from tag and send to host	#RFR + #RFH	
Lock / unlock fields (memory areas)	#RFL	There is no equivalent for this operation using the variable data handling approach.
Measurement (Hotspot test)	#RM	Only supported up to version x33.

5.3 Commands using the variable data handling mechanism

5.3.1 Definition of variables and data manipulation

User defined variables act as data storage, input values for RFID write operations or buffers for holding data read from tag.

There exist a lot of functions for manipulation of variable contents (like increment or decrement), concatenation or truncation and conversion between different coding schemes.

All EasyPlug commands, operators and functions related to the variable data handling mechanism are described in the EasyPlug manual [A0164].

Please see:

Commands: #VDT, #VDS, #VDD, #VTS, #VDE

Functions: Mod10, SubStr, Length, MergeRight, MergeLeft, DayOfYear

Additional functions for data manipulation (see section 5.3.3):

Functions: DecToBin, BinToDec, HexToBin, BinToHex, DualToBin, BinToDual, PadRigth, PadLeft

5.3.2 Data coding schemes / coding scheme conversion

Data can be handled inside EasyPlug using different coding schemes as described below. Having this opportunity makes it easy to do bit-manipulations or construct complex data fields from parts or data components. Data of any coding scheme can be stored in a text variable because there are no special characters or something like that may conflict with the used storage mechanism.

Important note: Data to be written to a tag must be provided in the binary coding scheme as parameter of the #VW/T command.

Data read from the tag is stored into a variable using the binary coding scheme. Before printing to a label it may be necessary to convert the data into the Hex (HexAscii) coding scheme.

Coding scheme	Description	Valid characters	Length
Bin (Binary)	Each character in a variable presents one physical byte	Any value a byte can have (0-255)	1 character = 1 byte of data
Hex (HexASCII)	HexAscii encoded binary data	0-9, A-F	2 characters = 1 byte of data
Dual (BinaryASCII)	Bitwise encoded binary data (MSB first orientation)	0/1	8 characters = 1 byte of data
Dec (Decimal)	Decimal presentation of numbers	0-9	Variable depending from value of the number

Table 15 – Data coding schemes

Examples

Data on tag memory dump in Hex Ascii notation	Data if directly transferred to Textvariable (1)(2)	Data after conversation using BinToHex (1)	Data after conversation using BinToDual (1)(3)	Date after conversation using BinToDec (1)
41 42 43 44	ABCD	41424344	01000001.01000010. 01000011.01000100	0
30 30 30 31	0001	30303031	00110000.00110000. 00110000.00110001	1
39 30 30 31	9001	39303031	00111001.00110000. 00110000.00110001	9001
00 10 11 FF	□□□□	001011FF	00000000.00010000. 00010001.11111111	0

(1) shown here as printed text on the label
(2) □ stands for an unprintable (non ASCII) character
(3) dots inserted for better readability

More examples: see section 6.2 for examples how to use functions and data conversion.

5.3.3 Functions

Function + syntax	Description
DecToBin(expression)	Converts decimal part of expression into binary string of bytes. Decimal number in expression must not exceed 2^64.
BinToDec(expression)	Converts expression into decimal number
HexToBin (expression)	Converts expression given as hexadecimal number represented in ASCII characters into binary representation. HexToBin(„3161“) returns „1a“
BinToHex (expression)	Converts expression to hexadecimal string
DualToBin (expression)	Converts dual expression to binary representation.
BinToDual (expression)	Converts expression to dual representation BinToDual(„1a“) returns „0011000101100001“
PadRight(expression, character, number)	Pads expression from right with given character until string length is equal to number PadRight(“111”,”2”,5) returns “11122”
PadLeft(expression, character, number)	Pads expression from left with given character until string length is equal to number PadLeft(“10101”,”0”,8) returns “00010101”

Table 16 – Functions for data conversion

5.3.4 Read and Write operations

Reading and/or writing data requires always the use of a variable + two explicit commands

1) Define a variable using #VDT (or #VDE / #VDD)
2) define target field (or data type) with **#SRF** command
3) read or write data with **#VR/T** or **#VW/T** command using the variable defined in 1) or an constant expression

The source of data to be written to the tag can be any variable or any constant expression used as DATA parameter in the #VW/T/ command.

The sink of data read from the tag can only be a text variable.

After reading data from the tag the data can be modified using the functions provided by the variable data handling mechanism, printed to the label or sent back to the host using the EasyPlug interface.

Order of execution

RFID operations are executed in the order which is given by the EasyPlug job. All RFID operations must complete before continuing with the regular printing of label. If there is a failure (due to an undetectable or bad RFID inlay or a verify after write error) the label is marked as invalid and processing is repeated with the next label of the web.

Note: if an error occurs no update of incrementing fields is made.

5.3.4.1 #SRF - RFID Read / write target definition

Definition

Command defines the target or source field and address of any following #VW/T or #VR/T command

Command must be placed between #ER and #Q!

Syntax	**`#SRFt/bfs/n/r#G`**	RFID printer

`#SRF`**`t`**`/bfs/n/r#G`

t = int data type / field
0 = BLOCK (*1, *2)
1 = TID (EPC Gen2), or UID (HF / ISO 15963) (*3)
2 = EPC (EPC Gen2)
3 = KILL Password (EPC Gen2)
4 = ACCESS Password (EPC Gen2)
5 = MEM BANK (EPC Gen2; Note: applies to read operations only) (*2)
6 = AFI
7 = MEMBLOCK (EPC Gen2; see note address calculation) (*1,*2)
8 = DSFID (HF / ISO 15963)

Notes:
*1) “s” parameter required

*2) “n” parameter required
*3) “n” parameter optional - for limiting size of data returned for read operations

#SRFt/**bfs**/n/r#G

opt. b = L Least significant byte of block first (default) :
Bytes of data (provided with the #VW/T command) are written on transponder beginning with the LSB first.
= M Most significant byte of block first:
Bytes of (provided with the #VW/T command) are written on transponder beginning with the MSB first.

opt. f = P locking option (write protect), default: don’t’ lock
(not implemented yet)

opt. s = int if data type is

BLOCK: Address of start block
MEM BANK: address / identifier of memory bank

MEMBLOCK: combination of memory bank identifier and address offset in the memory bank
scheme for address calculation:
s = <EPC MemoryBankID> * 1000 + <BlockNumber>
EPC MemoryBankID:
0 - reserved (Acces + Kill password)
1 – EPC
2 – TID
3 – USER
otherwise ignored.

Default setting: 0

#SRFt/bfs/**n**/r#G

opt. n = int Number of blocks to read, used if data type is BLOCK, TID, MEMBANK, or MEMBLOCK; ignored otherwise. Default setting: 0
for reading the field "TID" (t=1) the size parameter can be used to limit the size of the returned data; giving no size information will return the whole content of the TID memory bank which may contain more information than expected (depending from RFID transponder/chip)
typical default values:
2 => read 32-bit Vendor-ID/Chip-ID
4 => read 32-bit Vendor-ID/Chip-ID + 32-bit Unique Serial Number

#SRFt/bfs/n/**r**#G

opt. r = int Number of read/write retries. Default defined by parameter “Nr of CMD retries”.

5.3.4.2 #VR/T – Reading data from tag

Use #VR/T/<expression> command. For details see [A0164].

5.3.4.3 #VW/T – Writing data to the tag

Use the #VW/I/<expression> command. For details see [A0164].

5.3.5 Sending data (read from tag) to an interface

Sending data that was written to the tag or read from the tag back to the host requires the use of a variable + two explicit commands

1) Define a variable using #VDT
2) Read data from tag using #VR/T (or write data to tag using #VW/T)
3) define response format and point on time / condition (trigger) with **#SI** command
4) send data with **#VW/I** command using the variable defined in 1)

5.3.5.1 #SI – Response format definition

Definition	There is a response string made of header h and requested data that is send back to the host via EasyPlug Interface. If parameter n is different from zero the return string is trimmed to byte count n. If respond string is less than n bytes it is filled with blanks (hex code 0x20), otherwise respond string is truncated to fit into n bytes. Command must be placed between #ER and #Q!	
Syntax	**`#SIr/n/h#G`**	RFID printer

`#SI`**`r`**`/n/h#G`

r = int logical point in time concerning print control that defines when to send data (trigger point)

1 = at start of a new EasyPlug format
2 = at restart of a previous EasyPlug format (#Q without #ER)
3 = at start of a single label operation
4 = at start of RFID operation
5 = at end of successful RFID operation(s); if read/write operations fail the trigger doesn't fire
6 = at start of the real print process
7 = at end of the real print process
8 = at end of a single label operation (label printed without error)
9 = at end of an EasyPlug format (#Qn label printed)
10 = at any motion control error
11 = at any RFID error (tag read or tag write error); triggered together with the Bad Tag Signal

#SIr/**n**/h#G

n = int number of bytes to respond

#SIr/n/**h**#G

h = string header used as prefix of data to respond

For details see [A0164].

5.3.5.2 #VW/I – Sending data to the host

Use the #VW/I/<expression> command. For details see [A0164].

5.3.5.3 #RFC – Special RFID commands

Definition

Sends a command sequence to the RFID reader module to trigger special operations which are not mapped / part of the regular read/write/lock operations.
The commands are specific for a RFID reader module.

Command must be placed between #ER and #Q!

Syntax	**#RFC<cmd>#G**	RFID printer

#RFC<CMD>#G

<cmd> = int Command code
--- HF Technology / FEIG reader ---
(*1) EAS features
16 set EAS bit
17 reset / clear EAS bit
18 lock EAS bit permanently

(*1) EAS features only supported by NXP I-Code chips

5.3.5.4 #RFL – Write protect (Lock) and unprotect (Unlock) memory areas

Definition

Activate or disable the write protection (simple lock) of various memory areas of EPC Gen 2 tags. Before changing the write protection status first the access password must have once been written into to access password memory of the tag with a write command (#RFW or #SRF + #VW/T). For any attempt to change to protection status the same password must be provided as part of the #RFL command.
Please note: the #RFL command itself doesn't write to access password into to tag!
The #RFL command doesn't support the permalock option specified in the EPC Gen 2

standard. It implements only the write protection which can be reversed any time by issuing a unlock command with the right access password.

Command must be placed between #ER and #Q!

Syntax	**#RFLa/b/c/AccessPassword#G**	RFID printer

#RFL**a**/b/c/AccessPassword#G

a = Operation
1 = lock (write protect) memory area
0 = unlock (unprotected) memory area

#RFLa/**b**/c/AccessPassword#G

b = Memory area selection
0 = User memory
2 = EPC
3 = Kill password
4 = Access password

#RFLa/b/**BI**/AccessPassword#G

B = encoding of input data
B = hex ascii encoding: for the access password 8 chars must be provided
I = encoding of input data
I = raw data (binary data): for the access password 4 chars must be provided

#RFLa/b/BI/**AccessPassword**#G

AccessPassword = string
EPC Gen 2 specifies the access password with a size of 32 bit (4 bytes).
Depending from the data encoding (option c) 4 or 8 characters must be provided.

6 Applications / Examples

6.1 Hot spot test (UHF Technology)

Please note: the activation of the hotspot test via #RM command only supported in firmware version <= x.33.
Starting with X.34 version the test can be activated only via the menu.

Preparing the printer / print-job:
Set antenna offset to zero. Deactivate chip protection feature. Choose correct tag type (15)
Note: this is an example: Modify #IMSR for your label/tag needs. Especially label size.

sample job

```
#!A1
#IMSR102.0/155.0//15N/0/1/0
#ERN//
#RM0/0
#Q1#G
```

Please note: the hotspot test can also be initiated from the RFID parameters menu.

6.2 EPC class1 Gen2 features

6.2.1 Write / Read / Print EPC with 96bit (using variable data handling approach)

sample job

```
#!A1
#G-------------------------------------------------------------------------------
#G specify material settings
#G-------------------------------------------------------------------------------
#IMSR105/80//15N/38/3
#ER

#G-------------------------------------------------------------------------------
#G Define variables
#G-------------------------------------------------------------------------------
#G define your (static) EPC here using Hex ASCII encoding
#VDT/EPCDataWrite////3114F4DA34B2D05E01000000#G
#VDT/EPCDataVerify////#G
```

```
#G-------------------------------------------------------------------------------
#G Encode tag and print data
#G-------------------------------------------------------------------------------
#SRF2
#VW/T/HexToBin(EPCDataWrite)#G
#VR/T/EPCDataVerify#G
#SF103
#J21#T7#VW/L/"EPC (1: write to tag ): "+EPCDataWrite#G
#J25#T7#VW/L/"EPC (2: verify): "+BinToHex(EPCDataVerify)#G
#G-------------------------------------------------------------------------------
#Q1/
```

6.2.2 Write / Read / Print EPC with 96bit (using legacy commands)

Note: this job is composed using legacy commands. It's not the preferred approach to to RFID processing (see 5.1.2 Concepts of data handling)

sample job

```
#!A1
#IMSR100/150//15/35/1
#ERN//
#G Write EPC
#RFW2/B/3///24/313456789012345678901234#G
#G Read and Print EPC
#J22#T10#RT107/0/2/B/0/2
#J5#T6#YT107/0///RFID Gen II  EPC
#Q1/
```

6.2.3 Write / Read / Print EPC with consecutive numbering

Note: This job uses the variable data handling approach to define an auto incrementing value for the Serial number part of the EPC. This is the only way to compose a RFID job with auto incrementing fields.

sample job

```
#!A1
#G-------------------------------------------------------------------------------
#G specify material settings
#G-------------------------------------------------------------------------------
#IMSR105/80//15N/38/3V/41
#ER
```

```
#G-------------------------------------------------------------------------------
#G Define variables
#G-------------------------------------------------------------------------------
#VDT/EPCDataVerify////#G
#VDT/EPC_Header////00110001#G    #G SSCC-96 (dual/bitwise encoded)
#VDT/EPC_Filter////000#G         #G Filter value (dual/bitwise encoded), modify this to your needs!
#VDT/EPC_Partition////5#G        #G (dual/bitwise encoded)
#VDT/EPC_Company////4011661#G    #G Company code (decimal number) modify this to your needs!
#VDT/EPC_Unallocated////0#G

#G-------------------------------------------------------------------------------
#G starting value for serial number, modify this to your needs!
#G value is given as a decimal number
#G-------------------------------------------------------------------------------
#VDT/EPC_Serial//+1/1/3000000001#G

#G --- compose EPC SSCC96
#G ATTENTION: due to a change of the syntax of the PadLeft / PadRigth functions the right
#G expression/formula for the EPCDataWrite variable depending from the FW-version must
#G be selected
#G <<< syntax for FW-versions < Vx.33 >>>
#VDE/EPCDataWrite/DualToBin(
   PadLeft(EPC_Header,8,0)
  +PadLeft(EPC_Filter,3,0)
  +PadLeft(BinToDual(DecToBin(EPC_Partition)),3,0)
  +PadLeft(BinToDual(DecToBin(EPC_Company)),24,0)
  +PadLeft(BinToDual(DecToBin(EPC_Serial)),34,0)
  +PadLeft(BinToDual(DecToBin(EPC_Unallocated)),24,0)
)

#G <<< syntax for FW-versions >= Vx.33 >>>
#VDE/EPCDataWrite/DualToBin(
   PadLeft(EPC_Header, "0", 8)
  +PadLeft(EPC_Filter, "0", 3)
  +PadLeft(BinToDual(DecToBin(EPC_Partition)), "0", 3)
  +PadLeft(BinToDual(DecToBin(EPC_Company)), "0", 24)
  +PadLeft(BinToDual(DecToBin(EPC_Serial)), "0", 34)
  +PadLeft(BinToDual(DecToBin(EPC_Unallocated)), "0", 24)
)
#G <<< end of version depending expressions >>>
```

```
#G-------------------------------------------------------------------------------
#G Encode tag and print data
#G-------------------------------------------------------------------------------
#SRF2
#VW/T/EPCDataWrite#G
#VR/T/EPCDataVerify#G
#SF103
#J21#T7#VW/L/"EPC 1-to be written     : "+BinToHex(EPCDataWrite)#G
#J25#T7#VW/L/"EPC 2-verify after write: "+BinToHex(EPCDataVerify)#G

#G-------------------------------------------------------------------------------
#G each label is encoded with a consecutive serial number starting with value set in
#G EPC_Serial
#G-------------------------------------------------------------------------------
#Q3/
```

6.2.4 Write / Read / Print user data (NXP G2/G2XM, Alien Higgs 3 chips only) using legacy commands

sample job

```
#!A1
#PR8/8/
#G -- length/width
#G -- tag type = 15 (EPC class 1 Gen2)
#G -- tested with NXP G2 / G2XM chips from NXP (14/32 words = 28/64 bytes = 224/512 bits user data
adressed from 0..13/31)
#G -- antenna offset 60mm - adjust this to fit your needs !!
#G -- number of label to retry is 1
#IMSR100.0/67.0//15/60/1
#ERNF//
#G ----------------------
#G -- write EPC 96 bit based on SSCC-96
#RFW2/B/1///24/3114F4DC90B2D05E02000000
#G ----------------------
#G -- write 4 sets of blocks with 2 bytes per block
#G -- coding is hexadecimal (=option B) id est 2 characters define 1 byte
#G -- first set of 1 block (=2 bytes) starts at address 0 (= 0x00)
#RFW0/B0/0///4/0001
#G -- second set of blocks starting at address 2
#RFW0/B13/0///4/FFAA
#RFW0/0/0///14/123456789012345#G
#RFW0/0/0///14/123456789012345#G
#G ----------------------
#G read + print 4 blocks starting at address 0
```

```
#T1.0#J10.0
#YT103////Block 0..3:#G
#T20.0#J10.0
#RT103/0/0/B/0/4
#G read + print block starting at address 4
#T1.0#J14.0
#YT103////Block 4..7:#G
#T20.0
#RT103/0/0/B/4/4
#G read + print block starting at address 8
#T1.0#J18.0
#YT103////Block 8..11:#G
#T20.0
#RT103/0/0/B/8/4
#G read + print block starting at address 12
#T1.0#J22.0
#YT103////Block 12..13:#G
#T20.0
#RT103/0/0/B/12/2
#G read + print EPC
#T1.0#J30.0
#YT103////EPC:#G
#RT103/0/2/B/0/2
#Q1#G
```

6.2.5 Lock data fields (activating write protection + use of access password

To activate the write protection for data fields of an EPC Gen 2 tag 3 steps are necessary:
- Write the access password
- Lock the access password
- Lock the EPC area (or user memory area)

It's important to send commands in order listed above!

sample job

```
#!A1
#IMSR100/50.0//15/49/1
#ERN//

#G -- write access password
#RFW4/B/1///8/F1D2C300#G

#G -- Lock access password -
#G Please Note: this step is very important, otherwise the access password could be altered
#G and the protection of any other memory area could be disabled by this backdoor
#RFL1/4/B/F1D2C300#G
```

```
#G --- Write EPC
#RFW2/B/1///24/0102030405060708090A0B0C#G

#G --- Lock EPC (see notes to lock access password above)
#RFL1/2/B/F1D2C300#G

#Q1#G
```

6.2.6 Writing a SSCC-96 to tag

The following example it's assumed there is SSCC given with a partition value of 5 (7 digits company prefix and 9 digits serial reference). The extension digit and check digit are required and shall not be cut off before encoding.

```
#!A1
#IMSR105/130//15/52
#ER//

#G --- variable definition (static data)
#VDT/EPC_BS_Header////00110001#G EPC-96 binary header value for SSCC-96
#VDT/EPC_BS_Filter////010#G depends on your application, may be changed
#VDT/EPC_DV_Partition////5#G depends on your company prefix length
#VDT/EPC_BS_Free////000000000000000000000000#G 3-Byte, not used, constant 0

#G --- variable definition (Application data)
#VDT/SSCC////387137910010062064#G <<< INSERT YOUR COMPLET SSCC HERE (including extension digit and
check digit)

#VDE/EPC_DV_CompanyPrefix/SubStr(SSCC,1,7)
#VDE/EPC_DV_SerialRef/SubStr(SSCC,0,1)+SubStr(SSCC,8,9)

#G --- compose EPC SSCC96
#G ATTENTION: due to a change of the syntax of the PadLeft/PadRigth functions the right
#G expression/formula for the EPC96_BD variable depending from the FW-version must
#G be selected
#G <<< syntax for FW-versions < Vx.33 >>>
#VDE/EPC96_BD/DualToBin(
   PadLeft(EPC_BS_Header,8,0)
  +PadLeft(EPC_BS_Filter,3,0)
  +PadLeft(BinToDual(DecToBin(EPC_DV_Partition)),3,0)
  +PadLeft(BinToDual(DecToBin(EPC_DV_CompanyPrefix)),24,0)
  +PadLeft(BinToDual(DecToBin(EPC_DV_SerialRef)),34,0)
  +PadLeft(EPC_BS_Free,24,0)
)#G
```

```
#G <<< syntax for FW-versions >= Vx.33 >>>
#VDE/EPC96_BD/DualToBin(
   PadLeft(EPC_BS_Header, "0",8)
  +PadLeft(EPC_BS_Filter, "0",3)
  +PadLeft(BinToDual(DecToBin(EPC_DV_Partition)), "0",3)
  +PadLeft(BinToDual(DecToBin(EPC_DV_CompanyPrefix)), "0",24)
  +PadLeft(BinToDual(DecToBin(EPC_DV_SerialRef)), "0",34)
  +PadLeft(EPC_BS_Free, "0",24)
)#G
#G <<< end of version depending expressions >>>

#G --- write EPC-96 to transponder
#SRF2#G       set RFID chip access definition -> EPC
#VW/T/EPC96_BD#G

#G --- write SSCC and EPC96 on label
#SF106//#G    set fixed Font
#SS102//40#G  set scalable Font

#T5#J20#VW/L/"SSCC     (dec)= "+SSCC#G
#T5#J14#VW/L/"EPC      (hex)= "+BinToHex(EPC96_BD)#G
#Q1#G
```

The example above will write the EPC 315613D8FCB2DFB87E000000 to the tag (and print on the label).

6.2.7 EPC/EAN128 shipping label (SSCC + SSCC-96) + automatic transfer from Barcode SSCC (NVE) to EPC using a scanner

This sample shows how a SSCC (NVE) read from a barcode is transformed to a SSCC-96 EPC encoded following the EPC tag data standards.
All of this is based on the variable data handling approach and shows the potential of this for bringing “intelligence” inside the printer.

A usage scenario like this is also known as “slap & ship” solution.

The sample job produces a label where the layout and data content follows the GS1 recommendation for an EPC/EAN128 shipping label. The data printed is limited to the minimum required information: SSCC (NVE) - human readable and EAN128 bar code, EPC logo. The printed EPC code is only for demonstration – it’s not required on the shipping label.

The job is designed to be used a stand alone job to be loaded from a CF card, but by modifying the way to SSCC (NVE) is defined (read in), the job can also be used as an regular print job.

Jobs and logos files as embedded objects (not extractable from the PDF version):

Sample job	EPC logo (203 DPI)	EPC logos (300 DPI)
U:\Project\E257 (RFID UHF)\Applicatic (de) U:\Project\E257 (RFID UHF)\Applicatic (en)	U:\Project\E257 (RFID UHF)\Applicatic U:\Project\E257 (RFID UHF)\Applicatic	U:\Project\E257 (RFID UHF)\Applicatic U:\Project\E257 (RFID UHF)\Applicatic

sample job

```
#G --- EPC/EAN128 Shipping label sample ---
#G Material settings valid for A9272 (AD222 in 4x6" label)
#IMSR101.6/152.5//15N/55/0

#G --- PREREQUISITES ---
#G Download store on CF card the EPC Logo as EPCLOGO.BMP

#ERN/1//0
#R0/0

#G --- Definition of variables
#VDT/EPC_Header////00110001#G EPC-96 binary header value
#VDT/EPC_Filter////000#G 0: All Others, 1: Undefined, 2: Logical/Shipping unit, 3-7: reserved
#VDT/EPC_Partition////5#G depends on your company prefix length
#VDT/EPC_Free////00000000000000000000000#G not used, constant
#VDT/EPC96_Read////1#G
```

```
#G --- read SSCC/NVE from barcode scanner (or keyboard)
#VTS/NVE/Z/20///00340123451234567895#G
#G VDT/NVE////00340123451234567895#G

#G --- calculate check digit
#VDE/NVE_Pruefziffer/Mod10(SubStr(NVE,2,17))#G

#G --- convert NVE to EPC-96 (for partition value = 5)
#G ATTENTION: due to a change of the syntax of the PadLeft / PadRigth functions the right
#G expression/formula for the EPC96 variable depending from the FW-version must
#G be selected
#VDE/EPC_Company/DecToBin(SubStr(NVE,3,7))#G
#VDE/EPC_Serial/DecToBin(SubStr(NVE,2,1)+SubStr(NVE,10,9))#G

#G <<< syntax for FW-versions < Vx.33 >>>
#VDE/EPC96/DualToBin(
   PadLeft(EPC_Header,8,0)
  +PadLeft(EPC_Filter,3,0)
  +PadLeft(BinToDual(DecToBin(EPC_Partition)),3,0)
  +PadLeft(BinToDual(EPC_Company),24,0)
  +PadLeft(BinToDual(EPC_Serial),34,0)
  +PadLeft(EPC_Free,24,0)
)#G

#G <<< syntax for FW-versions >= Vx.33 >>>
#VDE/EPC96/DualToBin(
   PadLeft(EPC_Header, "0", 8)
  +PadLeft(EPC_Filter, "0", 3)
  +PadLeft(BinToDual(DecToBin(EPC_Partition)), "0", 3)
  +PadLeft(BinToDual(EPC_Company), "0", 24)
  +PadLeft(BinToDual(EPC_Serial), "0", 34)
  +PadLeft(EPC_Free, "0", 24)
)#G

#G <<< end of version depending expressions >>>

#G--- RFID OPERATIONS ---
#SRF2 #G  set RFID chip access definition -> EPC

#G --- write EPC-96 to transponder
#VW/T/EPC96#G

#G --- read back EPC-96 from transponder (optional)
```

```
#VR/T/EPC96_Read#G

#G --- PRINTING ---
#G --- print EPC on label
#T70 #J57
#FD/2/
#SF102#VW/L/"EPC (Hex) = "+BinToHex(EPC96_Read)#G

#G --- print barcode
#FD/1/
#T95 #J67
#SB15/MNXK/23/6
#VW/L/NVE#G

#G --- print SSCC (NVE)
#FD/1/
#T32 #J64 #SS101//119X80/0 #VW/L/SubStr(NVE,2,18) +" "+ NVE_Pruefziffer#G#G

#G --- graphics
#T61 #J60
#YG/1///C:\GRAPHICS\EPCLOGO.BMP#G

#G --- fixed data
#T0 #J60  #YL0/0/00.50/100
#T19 #J60 #YL0/1/00.50/90
#T64 #J60 #YL0/1/00.50/90

#FD/1/
#SF104
#T23 #J62  #VW/L/"NVE"#G
#T6 #J62  #VW/L/"Absender"#G
#SF103
#T9.5 #J64  #VW/L/"Avery Dennison"#G
#T13 #J64  #VW/L/"Ohmstrasse 3"#G
#T16.5 #J64 #VW/L/"85386 Eching"#G

#QX1#G
```

6.3 HF Technology Features

6.3.1 Modifying the EAS bit of NXP I-Code based inlays

EAS = electronic article surveillance

Use the #RFC command (see 5.3.5.3) to modify the EAS bit. Please note: the “Lock EAS” command is irreversible. After executing this command the EAS can’t be modified any more.

sample job

```
#!A1
#G Material: label size + Tag Type
#G-------------------------------------------------------------------------------
#IMSR105/80//0/38/1/0

#ER
#G-------------------------------------------------------------------------------
#G Set EAS, Reset EAS
#G-------------------------------------------------------------------------------
#RFC16
#RFC17

#G-------------------------------------------------------------------------------
#Q1/#G
```

7 References

[ISO15693] ISO 15693 Identification cards – Contactless integrated circuit(s) cards – Vicinity cards – Part 3: Anti-collision and transmission protocol

[EPC1] EPC global – EPC tag data standards
version 1.3, 8-March-2006

[EPC2] EPC global – Tag Data Translation (TDT)
revision 1.0, January-21-2006

[EPC3] EPC global – EPC Radio-Frequency Identity Protocols Class-1 Generation2 UHF RFID – Protocol for Communications at 860 MHz – 960 MHz
Version 1.2.0, 24-February-2008

For all EPCglobal normative documents see: www.epcglobalinc.org

[A0164] EasyPlug manual for Printers from Avery Dennison
available on the printer documentation CD
Version 4.05 and later

[AI-Manual] Service manual Applicator Interface ALX 92x
available on the printer documentation CD
Version 4.04 and later